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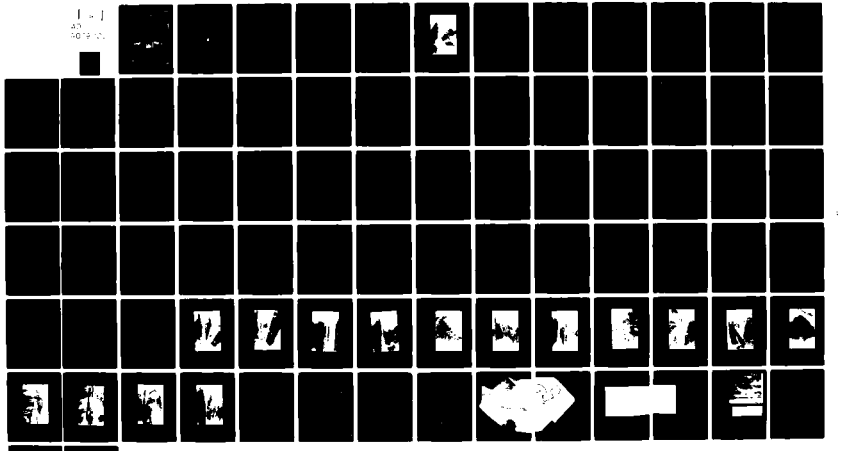

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DELAWARE RIVER BASIN
TROUT CREEK, MONROE COUNTY

PENNSYLVANIA
NDS ID PA. 00782
DER ID 45-8

BRADYS LAKE DAM

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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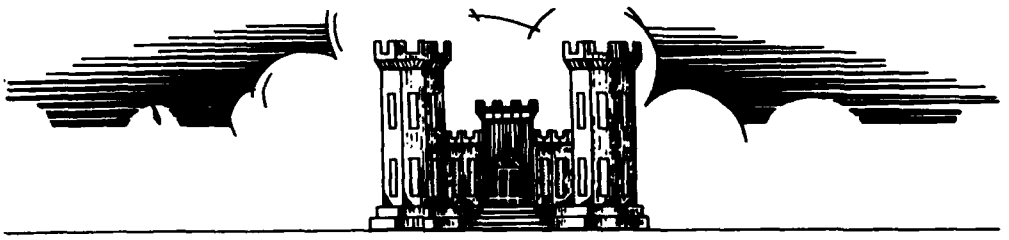

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

JULY 1979

DELAWARE RIVER BASIN

BRADYS LAKE DAM, MONROE COUNTY PENNSYLVANIA

NDS I.D. NO. PA 00782
DER I.D. NO. 45-8

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Brady's Lake Dam.
(NDS-ID-PA-00782) (DER-ID-45-8)
Delaware River Basin, Trout Creek, Monroe County, Pennsylvania.

DACW31-79-C-0017

Prepared by:

WOODWARD-CLYDE CONSULTANTS
5120 Butler Pike
Plymouth Meeting, Pennsylvania 19462

Submitted to:

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

JULY 1979

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I Investigations. Copies of these guidelines may be obtained from the Office of the Chief of Engineers, Washington, D. C., 20314. The purpose of a Phase I investigation is to expeditiously identify those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify the need for more detailed studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected, and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam:	Bradys Lake Dam
County Located:	Monroe County
State Located:	Pennsylvania
Stream:	Trout Creek
Coordinates:	Latitude 41° 9.8'
	Longitude 75° 31.8'
Date of Inspection:	1 May 1979

Bradys Lake Dam is owned by the Pennsylvania Game Commission. The dam was built in 1914 over a preexisting dam, Lower Dorney Dam, and was reconstructed in 1951 by the Pennsylvania Fish Commission. The facility is considered to be in fair condition. The dam is classified as a "High" hazard structure consistent with its potential in the event of failure to cause extensive property damage and possible loss of life to residents in the Arrowhead Lake development. The dam is classified as an "Intermediate" size dam by virtue of its 1,213 acre-foot normal storage capacity.

Design documentation was extremely limited. There were no as-built drawings and records indicate that, by today's standards, compaction of the embankment would have been considered, at best, marginal. However, the embankment slopes appear to be reasonable; there were no observed signs of slope instability and the embankment has performed satisfactorily for 65 years. Therefore, the embankment is at least marginally stable.

The hydrologic and hydraulic calculations presented in Appendix C and discussed in detail in Section 5 indicate that the spillway will not pass even 0.5 PMF without overtopping. However, since all conditions of a "Seriously Inadequate" spillway as defined by Corps of Engineers guidelines are not satisfied, the spillway is classified as "Inadequate".

Visual inspection of the dam disclosed signs of seepage along and beyond the downstream toe on the left side of the spillway. Based on records dating back to 1934, the seepage has not changed appreciably and has probably reached a stable condition.

Based on findings presented in this report, the following recommendations are presented in order of priority, but does not infer that the latter recommendations are not

important. All work should be performed under the direction of a registered professional engineer experienced in the design of dams.

1. Provisions should be made to increase the discharge capacity of the structure.

2. Seepage at the downstream toe should be periodically monitored and checked, at least visually, for increases in rates or turbidity.

3. The principal spillway should be rehabilitated to a good condition.

Since the facilities do not have a formal procedure of observation and warning during periods of high precipitation, such procedures should be developed and implemented. This procedure should also include a method of warning and possibly evacuating residents at Arrowhead Lake development. The operation and maintenance procedure should include an inspection checklist to insure that all items are regularly inspected and maintained in the best possible condition.

John Boschuk, Jr., P.E.
Pennsylvania Registration 27450E
Woodward-Clyde Consultants

7/30/79
Date

John H. Frederick, Jr., P.E.
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7/30/79
Date

APPROVED BY:

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

11 Sep 79
Date

OVERVIEW
BRADYS LAKE DAM, MONROE COUNTY, PENNSYLVANIA

TABLE OF CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
BRADYS LAKE DAM
NATIONAL ID #PA 00782
DER #45-8

SECTION 1
PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Bradys Lake Dam is an 18 foot high earth embankment constructed across Trout Creek. The dam has a maximum length of approximately 1,350 feet and impounds a 229 acre lake within a 7.49 square mile drainage area. The dam was built in 1914 over a preexisting dam and was reconstructed in 1961 by the Pennsylvania Fish Commission.

Drawings prepared in 1914 by I. E. Hartwell for the original owners, Brady Brothers, indicate the dam has a center section (the previous dam) about 3 feet wide and up to 11 feet high, consisting of clay and gravel puddled fill. On either side, the embankment is composed of loam and gravel, with upstream riprap on a 4H:1V slope and downstream riprap on a 2H:1V slope. It is reported that the clay puddle fill trench along the centerline was excavated into about 15 feet of rock.

The existing spillway is a masonry structure with a 46 foot total width. A single lane timber access bridge crosses the spillway, providing two feet of clearance between the spillway crest and the base of the bridge. In addition, at the left end of the dam is a 24-inch diameter culvert under the access road permitting some water to drain from the reservoir. There are no other known discharge facilities for this structure. There are no minimum flow requirements for this structure. Plans and profiles from available drawings are presented in Appendix E.

b. Location. Bradys Lake Dam was constructed across Trout Run in Coolbaugh Township, Monroe County, Pennsylvania. The dam site is located approximately 2.8 miles due north of Route 940, where the highway crosses Pocono Lake. The dam and reservoir are located on the "Thornhurst, Pennsylvania" Quadrangle at coordinates N 41° 9.8' W 75° 31.8'. A regional location plan of Bradys Lake and Dam is enclosed as Plate 1, Appendix E.

c. Size Classification. The dam is classified as an "Intermediate" size dam by virtue of its 1,213 acre-foot normal storage capacity.

d. Hazard Classification. A "High" hazard classification is assigned consistent with the potential for extensive property damage downstream and probable loss of life to residents of Arrowhead Lake Estates.

e. Ownership. The dam is owned by the Pennsylvania Game Commission. All correspondence should be sent to Mr. Glen L. Bowers, Executive Director, Pennsylvania Game Commission, Post Office Box 1567, Harrisburg, Pennsylvania 17120.

f. Purpose of Dam. The reservoir is used for recreation.

g. Design and Construction History. Prior to construction of the present dam, the area contained two dams known as Lower Dorney Dam, under the present dam, and an upper dam in the reservoir known as Beaver Dam. The difference in water levels upstream and downstream of Beaver Dam was about eight feet. In the spring of 1914, the Brady Brothers of Bayone City, New Jersey, submitted an application to construct a dam. The "Report Upon the Application of the Brady Brothers" was prepared July 15, 1914. The purpose of the new dam was to enlarge the pond for ice harvesting. At the time of this application, Lower Dorney Dam was about 200 feet long, 8 to 9 feet in height, with about a 20 foot wide crest width. The spillway was 23 feet wide and 1 foot deep.

The new dam, according to the application, was to be built over and around the old Dorney Lake Dam and would raise the reservoir level eight feet. The spillway of upstream Beaver Dam would be removed. Lower Dorney Dam would be between 18 and 19 feet in height and a reported 1,600 feet long. Approximately 500 feet of this length would be no more than 3 feet in height and about 700 feet would be from 3 to 5 feet in height. There are two main sections of the dam, which cross the valley, forming the high portions of the embankment. The upstream slope was to be covered with 36 inches of riprap

derived from native materials. The downstream slope was to be protected with 24 inches of riprap, also derived from native materials. According to the 1914 "Report Upon the Application", the existing dam had a 24-inch riveted steel pipe laid through the embankment with a concrete cutoff and an upstream plank gate operated from a tower. The spillway was to consist of two parallel concrete longitudinal walls 16 feet apart. The constructed spillway width was to be 50.5 feet after being redesigned by Mr. I. E. Hartwell of Wilkes Barre, Pennsylvania.

Material for the dam was obtained within the vicinity of the dam and consisted of topsoil and gravelly clay, containing a large percentage of stone. A review of the 1914 construction photographs confirms material types and placement procedures used for the dam. Placement of material was by horse-drawn wagons, deposited and spread in thin lifts, after the State Engineer recommended reducing lift thickness. Fill was compacted by driving dump wagons over the material. Specifications for soil placement were in DER files and reviewed. During construction, unsuitable fill placement methods were used, resulting in organic inclusions and poor compaction, as can readily be seen in the 1914 photographs. The August 4, 1914 progress report indicated better construction methods, including the use of a roller. Attempts were being made to stop leakage by upstream puddled fill. The August 28, 1914 progress report noted fill material was of fair quality and that the previous seepage was controlled, but seepage appeared at several places at the downstream toe of the dam and along the hillsides. However, according to State representatives, the seepage was assessed not to endanger the stability of the structure. The dam was built on glacial materials; as a result, during construction seepage continually posed problems so that a puddled clay wall was placed 14 or 15 feet into the foundation to control seepage. At one point, a September 30, 1914 inspection report concluded that extending the puddled core wall may be necessary to control seepage. Also, cutoff walls perpendicular to spillway abutment walls should be built.

All work was under the direct supervision of Mr. Jerome J. Brady and, in accordance with State records, it was concluded that the work was performed in a satisfactory manner, although clear seepage was noted in every progress report. The dam was eventually completed in 1915.

A September 21, 1978, photograph notes dry masonry abutments were constructed inside the original abutments. Timber bents were still used to support the bridge.

A 1934 State inspection report notes an auxiliary spillway 325 feet left of the spillway. A small discharge channel allowed water to drain from the reservoir. The depth was unknown. There is no later reference to an auxiliary spillway. In 1940, the Brady Brothers offered the dam and surrounding land for sale to the State. Records indicate that in January 1949, the lake's Owner was the Pennsylvania Game Commission. In 1960, the Pennsylvania Fish Commission decided to develop the lake area for public fishing and submitted a reconstruction application on August 26, 1960. As a result, the State of Pennsylvania issued the "Report Upon the Application of the Pennsylvania Fish Commission" on September 2, 1960. Reconstruction included regrading the downstream slope, new downstream riprap, asphalt roadway surface across the top of the dam, reconditioning spillway walls and bridge and a new 24-inch culvert installed at the left end of the dam. Subsequent to approval of this application, specifications and plans were prepared for the Pennsylvania Fish Commission by Mr. Thomas F. O'Hara, registered engineer. Subsequently, this work was performed in accordance with specification requirements.

h. Normal Operating Procedures. Under normal conditions, reservoir outflow is controlled by the spillway, located as shown on Plate 3, Appendix E. Water also flows through a 24-inch culvert located approximately 300 feet east of the spillway. There are no known pond drain valves or other means of draining this reservoir. Records do not disclose the continued existence of the blow-off pipe noted in Lower Dorney Dam prior to 1914.

1.3 Pertinent Data.

A summary of pertinent data for Bradys Lake Dam is presented as follows.

a.	Drainage Area (sq miles)	7.49
b.	Discharge at Dam Site (cfs)	
	Maximum Known flood	Unknown
	Maximum Discharge at Top of Dam (1,717.7)	127
	Minimum Required Flow	None
c.	Elevation[1]	
	Top of Dam (maximum)	1,719.5 (99.2)[2]
	(minimum)	1,717.7

(1) Elevations based on USGS bench mark at left end of dam.

(2) Elevations obtained from plans in Appendix E.

	Spillway Crest	1,716.0 (96.7)
	Top of Bridge (approximate)	1,719.2 (99.7)
	Invert of Overflow Pipe (approximate)	1,714.5 (95.2)
	Normal Pool	1,716.0 (96.7)
	Downstream Toe	1,701.5
d.	Reservoir (miles)	
	Length at Normal Pool	2.1
	Fetch at Normal Pool	1.3
e.	Storage (acre-feet)	
	Normal Pool	1,213
	Top of Dam (Elev 1,717.7)	1,782
f.	Reservoir Surface Area (acres)	229
g.	Dam Data	
	Type	Earth
	Length	1,350 feet
	Height	18 feet
	Crest Width	12 feet
	Volume of Fill	11,100 cu yds
	Side Slopes	
	Upstream	4H:1V
	Downstream	2H:1V
	Cutoff	Trench
	Grout Curtain	None
h.	Spillway	
	Type	Masonry weir & walls
	Width	46 feet
	Spillway/Bridge Clearance	2 feet
i.	Overflow	
	Type	Concrete pipe
	Diameter	24 inches
	Location	Left side of dam beneath roadway

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Availability. A summary of engineering data on Bradys Lake Dam is presented on the checklist attached as Appendix A. Principal documents containing pertinent data used for this report include "Report Upon the Application of the Brady Brothers" dated June 15, 1914; several construction progress reports, dated 1914; "Report Upon the Application of the Pennsylvania Fish Commission" dated September 2, 1960; and several inspection reports. Other documentation included several drawings dated 1914 and 1960. Letters of correspondence and miscellaneous documentation in Department of Environmental Resources' (DER) files were also available.

b. Design Features. Principal design features of the embankment and appurtenant structures are illustrated on the plan, profile and cross-section plates enclosed in Appendix E as Plates 2 through 4. A description of the features is also presented in Section 1.2, "Description of Project".

2.2 Construction.

A description of the construction history is presented in Section 1.2, paragraph g.

2.3 Operational Data.

There are no minimum flow requirements downstream of Bradys Dam. There is no operational data available for this structure.

2.4 Evaluation.

a. Availability. All engineering data reproduced in this report and studied for this investigation were provided by DER and supplemented by conversations with Pennsylvania Game Commission representatives who currently manage this dam.

b. Adequacy. Available data included in State files and presented in this report are not considered adequate to evaluate all the engineering aspects of this dam and its appurtenant structures in accordance with Corps of Engineers guidelines.

c. Validity. There is no reason to question the validity of the available data.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. Observations and comments of the field inspection team are contained in the checklist enclosed herein as Appendix B, and are summarized and evaluated in the following sections. In general, the appearance of the facility indicates the dam and its appurtenances are in fair condition.

b. Dam. Visual inspection of the dam revealed the upstream and downstream slopes were satisfactorily covered with rock. However, there were some irregularities of the upstream rock along the shoreline, which can be seen in Photograph 5. Inspection of the downstream slope disclosed no unusual movement or cracking along the slope or beyond the toe. It is pertinent to note that the toe of the two maximum sections of the dam are underwater, as shown in Plate 1, Appendix E. As shown in Photograph 12, the embankment crest is covered with asphalt and contains many longitudinal cracks. The 1960 photographs show similar cracks along the dam and, since that date, there appears to have been no appreciable change in the cracks. Alignment of the crest was checked and elevations varied from a low of 1,717 to a high of 1,719.5. These elevations are based on the USGS bench mark located at the left abutment. The embankment abutments appear to be in good condition with no excessive erosion or deterioration. The first points of overtopping are the abutments: the left abutment overtops with a reservoir level of 1,717 and the right abutment at 1,717.7.

Seepage was noted as shown on sheet 5a. All of this seepage was observed at the left end of the dam at the downstream toe between the 24-inch pipe and the spillway. This same seepage was noted in previous inspection reports, which date as far back as June 1934. Because of the backwater/swamp from the beaver dam, possible seepage under the right end of the dam may not be visible.

c. Appurtenant Structures.

Spillway. The masonry portion of the spillway, including abutment walls and bridge pier, appear to be in fair condition. The masonry walls will need rehabilitation in the near future as the mortar is deteriorating. The approach channel is shallow and rock lined, with vegetation growing underwater and at the water's edge. The discharge channel of

the principal spillway is densely vegetated and lined with random size rocks. The wooden bridge across the spillway is in fair condition, and there is approximately two feet of clearance between the top of the weir and the bottom of the bridge.

d. Reservoir. Reconnaissance of the reservoir disclosed the side slopes are stable and flat with woods to the water's edge. Reportedly, there is no sediment at the upper end to affect flood storage capacity.

e. Downstream Channel. The downstream channel flows 1.9 miles through swampy areas to the first downstream damage area 300 feet upstream of Arrowhead Lake. A typical view of the culvert just before Trout Run enters Arrowhead Lake is shown on Photographs 13, 14 and 15. Arrowhead Lake Dam is shown in Photograph 16.

Immediately below Bradys Dam, the area is flat and marshy partly as a result of a beaver dam constructed about 1,500 to 2,000 feet below the dam. The valley gradient is about 0.005.

3.2 Evaluation.

In summary, visual inspection of the structure disclosed no evidence of apparent past or present movement of the embankment or its appurtenant structures to indicate a potentially unstable condition. Seepage areas were noted at and just beyond the downstream toe on the left side of the embankment. Based on reports which date back as far as 1934, there has been little change to this seepage rate. The spillway is considered to be in fair condition. The wooden bridge over the spillway is expected to wash out during passage of a relatively large storm.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures.

Normal operating procedures do not require a dam tender. Water level is maintained by the spillway weir. Based on discussions with representatives of the Pennsylvania Game Commission, there is no means of lowering this reservoir in the event of an emergency.

4.2 Maintenance of the Dam.

The dam is maintained by the Pennsylvania Game Commission. Maintenance normally consists of cutting grass, removing woody vegetation from the slopes and repairing the crest of the dam or resurfacing the road, as necessary.

4.3 Maintenance of Operating Facilities.

Maintenance of operating facilities consists of maintenance of the spillway. This work is performed by the Pennsylvania Game Commission, who periodically collect debris from the spillway approach area, inspect the bridge and maintain a clear way for passage of flows through the spillway.

4.4 Warning Systems In Effect.

There are no formal warning systems or procedures specifically established for this structure which are to be followed during exceedingly heavy rainfalls.

4.5 Evaluation.

There are no written operational procedures, maintenance procedures or any type of warning system. Maintenance and operating procedures should be developed, including a checklist of items to be observed, operated and inspected on a regular basis. Since a specific warning procedure for this facility does not exist, one should be developed and implemented during periods of extremely heavy rainfall. This procedure should consist of a detailed method of notifying residents downstream that potentially high flows are imminent or a dangerous condition is developing.

SECTION 5
HYDROLOGY/HYDRAULICS

5.1 Evaluation of Features.

a. Design/Evaluation Data. The only data available was a 1940 State inspection report showing the spillway section, length and capacity evaluation. No evaluation of spillway adequacy was made at that time. In 1960, the spillway abutment walls were repaired and the bridge piers replaced. Additional calculations for this 1979 investigation are presented in Appendix C.

The watershed is leaf shaped, about 4 miles long and 0.9 to 2.6 miles wide, having a total area of 7.49 square miles. Elevations range from a high of 1,960 to normal pool level of 1,716. It is almost completely wooded with no residential development. Scattered throughout the watershed are several swamps, visually estimated from USGS maps to be 1.5 to 2 square miles. Runoff characteristics of the watershed are not expected to change in the foreseeable future.

In accordance with criteria established by Federal (OCE) Guidelines, the recommended spillway design flood for this "Intermediate" size dam and "High" hazard potential classification is the Probable Maximum Flood (PMF).

b. Experience Data. There are no records of reservoir water levels or rainfall within this watershed. There are no estimates of previous high water levels.

c. Visual Observations. On the date of inspection, the only condition observed that would indicate a reduction in spillway capacity during a large storm are the low points of the abutments. The left abutment is only one foot higher than the spillway and the right abutment is 1.7 feet higher than the spillway crest. Clearance between the spillway crest and the underside of the bridge is limited to about two feet. When the reservoir overflows, water will first flow over the right abutment at the culvert.

d. Overtopping Potential. Overtopping potential of this dam was estimated using "HEC-1, Dam Safety Version", computer program. A brief description of the program is included in Appendix C. Although the embankment is fairly long, the height is very low over about half its length. Downstream of the low embankment sections are woods and brush on a flat slope. When the embankment overtops, flow over the

low portions will be hindered by the downstream woods. During the visual inspection, an estimate was made of the portions of the embankment which will act as a weir during overtopping and those sections that will act as a channel. Discharge through the channel sections were calculated and added to the spillway discharge and inputted directly to the computer program. The program calculated discharge over those portions of the embankment acting as a weir by critical depth. When the spillway is discharging at maximum capacity (reservoir level at the underside of the bridge) water is already flowing over both the left and right abutments. The spillway capacity with reservoir level at 1,717, the elevation of the right abutment, is about 125 cfs. The maximum spillway capacity, with reservoir level at 1,718, is about 360 cfs. The HEC-1 program computed the peak PMF inflow to be 8,780 cfs.

As shown in Appendix C, the left abutment is overtopped by 0.1 PMF and the right abutment by 0.2 PMF. The highest point of the embankment is not quite overtopped by 0.5 PMF although the rest of the embankment is being overtopped. No allowance has been made for flood water storage in the many upstream swamps. As most of the embankment is overtopped by 0.5 PMF, the program was run a second time with an assumed failure criteria.

e. Spillway Adequacy. A spillway that will not pass 0.5 PMF without overtopping the dam is rated as "Seriously Inadequate", provided two other conditions are present. One is failure of the dam by overtopping. As shown in Appendix C, pages 13 and 14, the assumed failure criteria indicates the dam will fail during storms equal to or greater than the 0.5 PMF event.

The second requirement for a "Seriously Inadequate" spillway is that the downstream damage occurring after failure is significantly greater than that which would occur for high flows just before failure. The first downstream damage center is about 1.9 miles downstream of Bradys Lake Dam. There are four to five homes along Trout Creek subject to damage in the event of high flows. About 1,300 feet farther downstream, Trout Creek enters Arrowhead Lake, a man-made reservoir. Visual inspection of Arrowhead Dam indicated a large swale in the left abutment about two feet below design elevation of the dam. This swale is the first point of overtopping. During an 0.75 PMF event, water will flow through the swale in Arrowhead Dam, assuming no upstream failures.

Comparison of water levels at both the downstream culvert and Arrowhead Lake, assuming no failure and then failure of Bradys Dam, do not indicate a significant increase

in water levels as a result of failure. It is to be noted that the computed water levels are conservative, i.e., may be low, as no allowance is made for the additional seven square miles of watershed above Arrowhead Lake.

As significant increase in damage resulting from failure is not expected, the spillway is rated as "Inadequate" but not "Seriously Inadequate".

f. Downstream Conditions. The downstream conditions have been discussed in Section 3 and the above paragraph.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. Field inspection disclosed no evidence of potential instability of the dam or its components. The downstream slopes are reasonably uniform with no signs of significant riprap displacement or sloughing. The downstream slopes are in good condition. Woody vegetation is beginning to develop on the slopes, but is regularly cut down by the maintenance staff. Minor signs of riprap displacement were noted along the upstream slope. Pennsylvania Game Commission personnel attribute the stone displacement to vandalism.

The spillway is judged to be in fair condition. It is judged that the rubble masonry walls and the bridge pier in the midpoint of the spillway would probably fail during passage of extremely severe storms.

b. Design and Construction Data. All available documentation, drawings and data received from the Department of Environmental Resources, supplemented by conversations with the Pennsylvania Game Commission, were assessed and reviewed. Most documentation referred to construction methods and materials. Poor materials and fill placement methods were used during the early stages of the 1914 reconstruction. By today's standards, compaction of the embankment would be considered marginal.

There are no original embankment or spillway stability calculations. However, embankment slopes appear to be reasonable and there were no observed signs of slope instability. The service record indicates the embankment has been stable for at least 65 years. Thus, based on the 65 years of performance and long-term steady state seepage which has been occurring without apparent change along the left abutment, stability of the slopes is judged as at least adequate.

c. Operating Procedures. There are no written operating procedures for the dam.

d. Post-Construction Changes. Since the major reconstruction work in 1914, the only major reconstruction that has been performed is the rehabilitation work performed by the Pennsylvania Fish Commission in 1960. Rehabilitation of the spillway has resulted in a shorter weir than that constructed in 1914. A discussion of this reconstruction work is presented in Section 1 of the report.

e. Seismic Stability. The dam is located in Seismic Zone 1. Normally it can be considered that if a dam in this zone is stable under static conditions with conventional margins of safety, it can be assumed safe for any expected earthquake conditions. Since the static stability analysis was not available to show adequate static factors of safety, the seismic stability of the dam could not be evaluated.

SECTION 7
ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Evaluation. Visual inspection and review of the design and construction documentation indicates the dam and appurtenant structures of Bradys Lake are in reasonably fair condition. As discussed in Section 5 of this report, the hydrologic and hydraulic computations presented in Appendix C indicate the dam has a spillway that is rated as "Inadequate" but not "Seriously Inadequate". There are downstream houses subject to damage and the possibility of loss of life exists. Therefore, the structure is considered a "High" hazard potential dam.

The wet areas, noted on sheet 5a, Appendix B, downstream of the embankment to the left of the spillway have been a source of seepage for more than 45 years. Based on available documentation, there has been no significant change in the rate of seepage for at least that period of time. Thus, it is judged that this seepage is in a reasonably stable condition, but does not discount the fact that it should be monitored.

b. Adequacy of Information. The combined design information, construction data, visual inspection and obvious performance history of this structure were sufficient to evaluate the dam and appurtenant facilities.

c. Urgency. It is concluded that recommendations presented in Section 7.2 be implemented as soon as practical.

7.2 Remedial Measures.

a. Facilities. The following recommendations are presented in order of priority, but this does not infer that the latter recommendations are not important. All work should be under the direction of, or at least reviewed by, a registered professional engineer experienced in the design of dams.

1. Provisions should be made to increase the discharge capacity of the structure. One possible solution would be to construct an auxiliary spillway at either or both abutments.

2. Seepage at the downstream toe should be periodically monitored and checked, at least visually, for increases in rates or changes in turbidity.

3. The spillway should be rehabilitated to a good condition.

b. Operation and Maintenance Procedures. Because of the location of the dam upstream of a populated area (Arrowhead Lake development) with the potential to cause extreme property damage and possible loss of life, a formal procedure of observation and warning during periods of high precipitation should be developed and implemented. This procedure should also include a method of warning downstream residents that high flows are expected, together with a method of evacuating these people. The Pennsylvania Game Commission should develop an inspection checklist and maintenance procedure which would be used to regularly inspect and maintain all items of this structure.

APPENDIX

A

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM *Brady Dam*

ID # *PA 00782*

ITEM	REMARKS
AS-BUILT DRAWINGS	*None available. A few design drawings were available, field checked and are presented in Appendix E.*
REGIONAL VICINITY MAP	*See Plate 1, Appendix E.*
CONSTRUCTION HISTORY	*A discussion is presented in Section 1.*
TYPICAL SECTIONS OF DAM	*See Appendix E.*
OUTLETS - PLAN	*Available data presented in Appendix E.*
DETAILS	
CONSTRAINTS	
DISCHARGE RATINGS	*- None available.*
RAINFALL/RESERVOIR RECORDS	*- None available.*

ITEM	REMARKS
DESIGN REPORTS	*None available.*
GEOLOGY REPORTS	*None available. Information obtained for this inspection is presented in Appendix F.*
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS	*See Appendix C.*
DAM STABILITY SEEPAGE STUDIES	*None available.*
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	*No data cvailable.*
POST-CONSTRUCTION SURVEYS OF DAM	*None*
BORROW SOURCES	*Unknown*

ITEM	REMARKS
MONITORING SYSTEMS	*None*
MODIFICATIONS	*None*
HIGH POOL RECORDS	*Unknown*
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	*None*
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	*None*
MAINTENANCE OPERATION RECORDS	*None*

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	*See available data in Appendix E.*
OPERATING EQUIPMENT PLANS & DETAILS	*Not available.*
MISCELLANEOUS	1. *"Application" dated 26 August 1960 and "Permit" to construct dated 26 September 1960.* 2. *38 black and white photographs. Most were taken in 1915.* 3. *Progress reports for 1961 reconstruction submitted by Mr. Thomas F. O'Hara, Chief Engineer.* 4. *"Specifications for Reconditioning Existing Dam", by Thomas F. O'Hara* 5. *DER inspection reports. (latest report dated 11/7/66)* 6. *"Report Upon the Application of the Pennsylvania Fish Commission" dated September 2, 1960* 7. *Miscellaneous progress reports.*

APPENDIX

B

CHECK LIST
VISUAL INSPECTION
PHASE I

Name Dam *Bradys Lake Dam* County *Monroe* State *Pennsylvania* National ID # *PA 00782*

Type of Dam *Earth* Hazard Category *I-High*

Date(s) Inspection *1 May 1979* Weather *Clear to partly cloudy, cool* Temperature *Mid 50's*

Pool Elevation at Time of Inspection *1715.9* M.S.L. Tailwater at Time of Inspection *1712±* M.S.L.

Inspection Personnel:

John Boschuk, Jr. (Geotechnical) *Raymond Lambert (Geologist)* *John H. Frederick (Geotechnical)*

Mary F. Beck (Hydrologist) *Vincent McKeever (Hydrologist)*

John Boschuk, Jr. Recorder

Remarks:

Messrs. J. Serfass, Land Management Officer; Victor Kosinski, Foreman; and L.I. Harshbarger, Assistant Superintendent were on site and provided assistance to the inspection team.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	*N/A*	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	*N/A*	
DRAINS	*N/A*	
WATER PASSAGES	*N/A*	
FOUNDATION	*N/A*	

CONCRETE/MASONRY DAMS

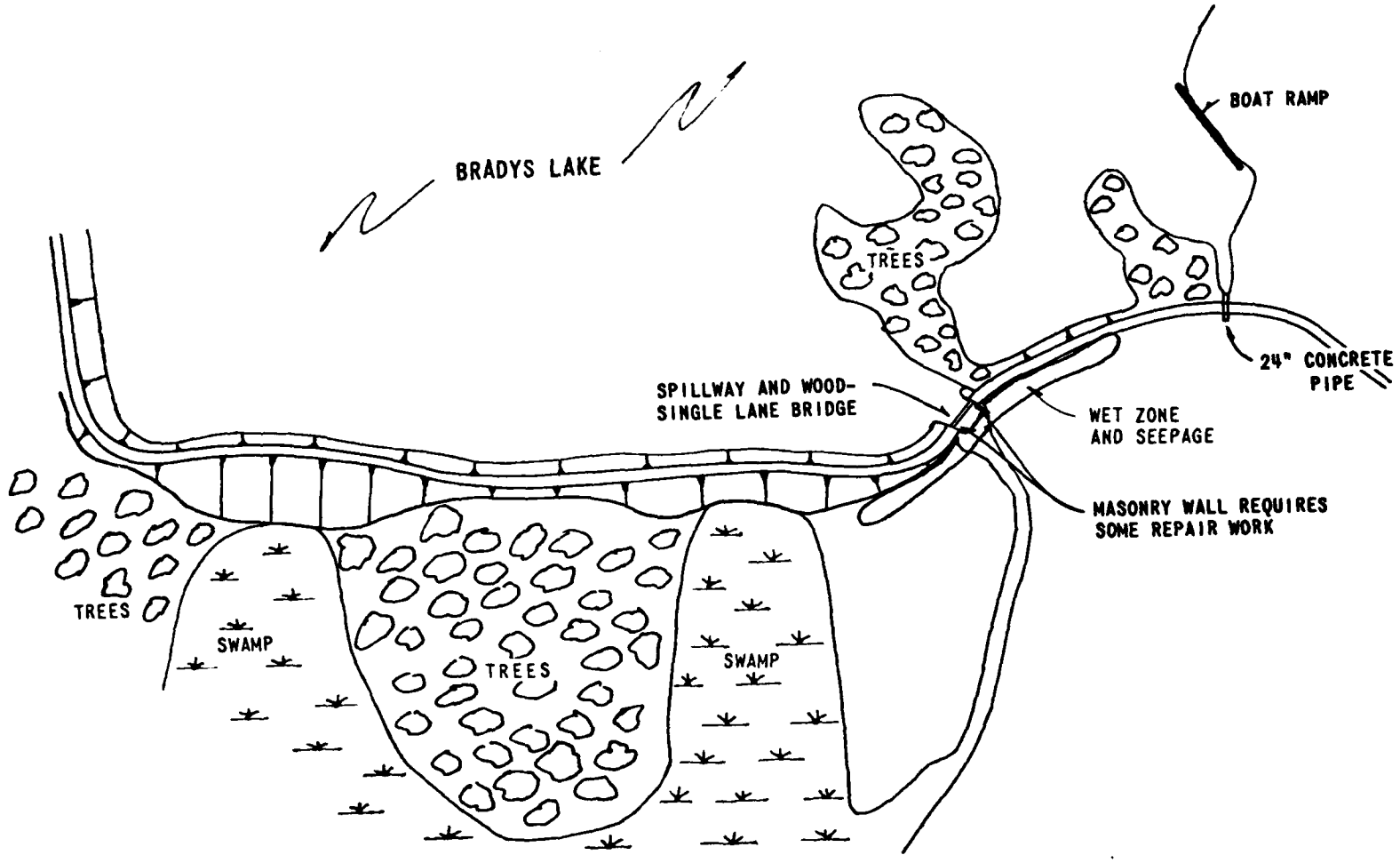
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	*N/A*	
STRUCTURAL CRACKING	*N/A*	
VERTICAL AND HORIZONTAL ALIGNMENT	*N/A*	
MONOLITH JOINTS	*N/A*	
CONSTRUCTION JOINTS	*N/A*	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	*Asphalt covered road contains many horizontal cracks and has been repaved and patched many times.*	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	*None observed.*	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	*The upstream slope is irregular with areas of riprap displacement and movement. However, none of this movement appears to be associated with instability.*	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	*This alignment was checked and is shown on Plate 3, Appendix E. The elevation varies from a low of 1717.7 to a high of 1719.5 based on a USGS bench mark at the end of the dam.*	
RIPRAP FAILURES	*None observed.*	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	*The abutments are in good condition with no excessive erosion or deterioration.*	
ANY NOTICEABLE SEEPAGE	*Yes. See Sheet 5a, all of the seepage was observed at the left end of the dam at the downstream toe between the 21 inch pipe and the spillway.*	
STAFF GAGE AND RECORDER	*None*	
DRAINS	*Unknown. None are believed to exist.*	



FIELD OBSERVATION PLAN
BRADYS LAKE DAM

SHEET 5A OF 11

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	*None*	
INTAKE STRUCTURE	*None*	
OUTLET STRUCTURE	*None*	
OUTLET CHANNEL	*None*	
EMERGENCY GATE	*None*	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MASONRY	*Fair condition.*	
APPROACH CHANNEL	*The channel is shallow, rock lined with vegetation growing underwater and at the water's edge.*	
DISCHARGE CHANNEL	*Densely vegetated channel lined with random rock.*	
BRIDGE AND PIERS	*Board and log bridge with a masonry center pier. There is approximately two feet of clearance between the top of the weir and the bottom of the bridge.*	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	*N/A*	
APPROACH CHANNEL	*N/A*	
DISCHARGE CHANNEL	*N/A*	
BRIDGE AND PIERS	*N/A*	
GATES AND OPERATION EQUIPMENT	*N/A*	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	*None*	
OBSERVATION WELLS	*None*	
WEIRS	*None*	
PIEZOMETERS	*None*	
OTHER	*None*	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	*Reservoir side slopes are stable, flat with woods to water's edge.*	
SEDIMENTATION	*Reportedly no sediment at upper end, no effect on flood storage.*	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	*Immediately below the dam the area is flat and marshy, partly as a result of a downstream beaver dam.*	
SLOPES	*The valley gradient is about 0.005.*	
APPROXIMATE NO. OF HOMES AND POPULATION	*About two miles below the dam, Trout Creek flows through Arrowhead Lake residential development where homes are built adjacent to the stream. About 2.25 miles below Brady Dam, Trout Creek enters Arrowhead Lake.*	

APPENDIX

C

BRADYS LAKE
CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: *Wooded, marshy, no residential development.*

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): *1716 feet (1213 Acre-Feet).*

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): *1717 feet (1213 Acre-Feet)*

ELEVATION MAXIMUM DESIGN POOL: -------

ELEVATION TOP DAM: *1717 feet at left abutment, 1717.7 feet at right abutment*

SPILLWAY

a. Elevation *1716 feet.*

b. Type *Concrete weir.*

c. Width *41 feet.*

d. Length *N/A*

e. Location Spillover

f. Number and Type of Gates *None.*

OUTLET WORKS:

a. Type *None known.*

b. Location ----

c. Entrance inverts ----

d. Exit inverts ----

e. Emergency draindown facilities *None*

HYDROMETEOROLOGICAL GAGES:

a. Type *None.*

b. Location *Not applicable.*

c. Records *Not applicable.*

MAXIMUM NON-DAMAGING DISCHARGE: *Not determined.*

HEC-1, REVISED
FLOOD HYDROGRAPH PACKAGE

The original "Flood Hydrograph Package" (HEC-1), developed by the Hydrologic Engineering Center, Corps of Engineers, has been modified for use under the National Dam Inspection Program. The "Flood Hydrograph Package (HEC-1), Dam Safety Version", hereinafter referred to as, HEC-1, Rev., has been modified to require less detailed input and to include a dam breach analysis. The required input is obtained from the field inspection of a dam, any available design/evaluation data, relatively simple hydraulic calculations, or information from the USGS Quandrangle maps. The input format is flexible in order to reflect any unique characteristics of an individual dam.

HEC-1, Rev. computes a reservoir inflow hydrograph based on individual watershed characteristics such as: area, percentage of impervious surface area, watershed shape, and hydrograph characteristics determined from regional correlation studies by the Corps of Engineers, Baltimore District. The inflow is routed through the reservoir using spillway discharge data obtained from the field inspection or design data. Flood storage capacity is determined from USGS maps or design information and verified by the field inspection. In the event a spillway cannot discharge 0.5 PMF without overtopping and failure of the dam, downstream channel characteristics obtained from the field inspection and USGS maps are inputed and flows are routed downstream to the damage center and a dam breach analysis is performed.

Included in this Appendix are the HEC-1, Rev. pertinent input values and a summary print-out tables.

BY MEB DATE 6/13/79 SUBJECT Bradys Lake SHEET 3 OF 14

CKD. BY [illegible] DATE 7/25/79 JOB No.

Classification (Ref: Recommended Guidelines for Safety Inspection of Dams)

1. The hazard potential is rated as "High" there would be loss of life if the dam failed.

2. The size classification is "Intermediate" based on its normal storage capacity of 1213 Ac-Ft.

3. The spillway design flood, based on size and hazard classification, is the Probable Maximum Flood (PMF).

Hydrology and Hydraulic Analysis

1. Design/Evaluation Data - None located for the existing spillway. Reservoir/Drainage Area data from drawing dated 6/8/60 prepared for the State:

spillway crest elev.	1716.0 USGS datum
normal pool surface	229 Ac
drainage area	0.49 sq. miles

2. Evaluation of structure was by use of the computer program. Computer input data as follows:

Inflow hydrograph
rainfall, shown on sheet 7, ref. Hydrometerological Report No. 33
drainage area - the above area verified by current USGS maps
Snyder's hydrograph parameters, t_p & C_p

$t_p = C_t (L \cdot L_{ca})^{0.3}$

$C_t = 2.1$ } Information received from Corps of
$C_p = 0.45$ } Engineers, Baltimore, for Zone 2.
$L = 5.16$ miles } from USGS
$L_{ca} = 2.60$ miles } maps

$t_p = 2.1 (5.16 \cdot 2.60)^{0.3} = 4.58$

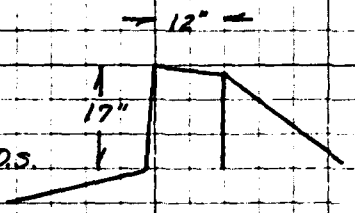
BY MEB DATE 6/19/79 SUBJECT Brady's Lake Hydrology / Hydraulics SHEET 8 OF 14

CHKD. BY DATE JOB No.

Reservoir routing

elevation - storage, shown on sheet 8
normal storage measured from the 6/8/60 dwg.
flood storage measured from USGS maps

elevation - discharge, shown on sheet 8



$Q = CLH^{3/2}$

assume $C = 3.1$ for $H < 2.0$ ft (the underside of the bridge)

$L = 41$ ft. measured

for $H > 2.0$ ft $Q = C \cdot A \sqrt{2gH}$

assume $C = 0.6$

$A = 41 \cdot 2'$

for $H > 3.3$ ft, assume bridge acts as broadcrested weir, $C = 2.6$, in addition to orfice flow under bridge - assume bridge is not dislodged, conservative.

discharge over top of dam

flow over 780 ft. of the embankment will not be affected by downstream conditions and the profile is entered in the program and discharge computed by critical depth.

flow over the rest of the embankment is considered as open-channel flow. The flow, estimated by Manning's equation, is combined with the spillway discharge.

$Q = L \cdot 1.49/n \cdot d^{1.666} \cdot S^{1/2}$

L = length of embankment acting as channel
n = estimated in field
S = estimated as 0.001
d = depth over embankment

assumed channel sections

L	80 ft	120 ft	70 ft	120 ft	390 ft
n	0.06	0.06	0.05	0.06	0.07
invert elev.	1717 ft	1717.3 ft	1717.7 ft	1717.9 ft	1718.3 ft

BY MEB DATE 6/15/79 SUBJECT Bradys Lake Hydrology/Hydraulics SHEET 5 OF 14

CKD. BY JN DATE JOB No.

Downstream Conditions

First downstream culvert, Photographs 14 & 15.
Height of water was estimated considering the roadway as a dam.
elevation-storage, estimated from USGS map.
elevation-discharge, sheet 9, considering inlet control for 2-7ft CMP culverts.

Arrowhead Lake

elevation-storage, estimated from USGS map
elevation-discharge, calculated by computer

$Q = C \cdot L \cdot H^{3/2}$

C = 3.6 est. from Tab. 5-3, King & Brater, Handbook of Hydraulics
L = 110 ft (from dwg supplied by owner's engineer)

Swale, Photograph 16.
depth below spillway wall measured
width, estimated in field

Overtopping Potential

The minimum elevation, at left abutment, is overtopped by 0.1 PMF. During 0.5PMF, the reservoir level is computed to be 1719.47 ft. vs. maximum embankment elevation of 1719.5 ft.

Rainfall Data - Examination of Hurricane Diane, Aug. 1955, rainfall distribution map discloses Bradys Lake watershed rainfall may be approximated by the rainfall at Meadow Run Pond station.

	Maximum Rainfall	PMP* Rainfall	% PMP
6 hr	4.91"	24.75"	19.8
12 hr	6.07"	27.65"	22.0
24 hr	7.68"	29.88"	25.7
48 hr	8.60	31.67	27.3

* from Hydrometeorological Report No. 33

HEB 6/20/79 Bradys Lake Hydrology/Hydraulics SH. 6 OF 14

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	BLI
ROUTE HYDROGRAPH TO	BLO
ROUTE HYDROGRAPH TO	CHR
ROUTE HYDROGRAPH TO	AHO
END OF NETWORK	

1**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****

RUN DATE= 79/06/19.
TIME= 09.41.01.

BRADYS LAKE DAM
NAT ID NO. PA 00782 DER NO. 45-8
OVERTOPPING ANALYSIS

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
150	0	20	0	0	0	0	0	-4	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 6 LRTIO= 1

RTIOS= .10 .20 .30 .50 .80 1.00

HEC 4/10/79 Brady's Lake Hydrology / Hydraulics sh. 7 of 14

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
BLI	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

INHYD	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	7.49	0.00	7.49	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.30	111.00	124.00	134.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 4.58 CP= .45 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG= 4.56 HOURS, CP= .45 VOL= .99

9.	32.	67.	108.	154.	204.	258.	312.	362.	404.
439.	465.	482.	489.	478.	458.	438.	418.	399.	381.
364.	348.	332.	317.	303.	290.	277.	264.	252.	241.
230.	220.	210.	201.	192.	183.	175.	167.	160.	153.
146.	139.	133.	127.	121.	116.	111.	106.	101.	96.
92.	88.	84.	80.	77.	73.	70.	67.	64.	61.
58.	56.	53.	51.	49.	46.	44.	42.	40.	39.
37.	35.	34.	32.	31.	29.	28.	27.	26.	24.
23.	22.	21.	20.	19.	19.	18.	17.	16.	15.
15.	14.	13.	13.	12.	12.	11.	11.	10.	10.

0 END-OF-PERIOD FLOW

NO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	NO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	25.33	22.95	2.38	231539.
										(643.)	(583.)	(60.)	(6556.45)

HYDROGRAPH ROUTING

BRADYS LAKE OUTFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
BLO	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1716.	-1

STAGE	1716.00	1717.00	1717.30	1717.70	1717.90	1718.30	1719.00	1720.00	1721.00	1724.00
FLOW	0.00	127.00	196.00	337.00	431.00	652.00	1267.00	2736.00	4842.00	8224.00

CAPACITY=	0.	78.	300.	830.	1213.	2553.	4741.
ELEVATION=	1699.	1704.	1709.	1714.	1716.	1720.	1724.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1716.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1717.7	0.0	0.0	0.

CREST LENGTH	0.	175.	240.	630.	780.	780.
AT OR BELOW ELEVATION	1717.7	1718.2	1718.3	1719.2	1719.5	1725.0

MFB 6/20/75 Bradys Lake 3W. B OE 14

MFB 6/30/99 Brady's Lake Hydrology / Hydraulics SK 9 OF 14

HYDROGRAPH ROUTING

CHANNEL ROUTING AS A RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
CHR	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
0.0	0.000	0.00	1	1	0	0		0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1662.	-1

✓

STAGE	1662.00	1669.00	1672.00	1676.00	1683.00
FLOW	0.00	520.00	800.00	1000.00	1350.00
CAPACITY=	0.	52.	527.		
ELEVATION=	1662.	1670.	1680.		

✓

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1662.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1672.3	0.0	0.0	0.

CREST LENGTH	0.	62.	180.
AT OR BELOW ELEVATION	1672.3	1673.5	1677.9

HYDROGRAPH ROUTING

ARROWHEAD OUTFLOW

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
AHO	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
0.0	0.000	0.00	1	1	0	0		0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1648.	0

CAPACITY=	0.	2724.
ELEVATION=	1648.	1660.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1648.0	110.0	3.6	1.5	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1653.3	0.0	0.0	0.

CREST LENGTH	30.	75.	210.	300.
AT OR BELOW ELEVATION	1653.3	1654.9	1655.0	1658.0

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .10	RATIO 2 .20	RATIO 3 .30	RATIO 4 .50	RATIO 5 .80	RATIO 6 1.00
HYDROGRAPH AT	BLI	7.49	1	878.	1756.	2634.	4390.	7024.	8780.
		(19.40)	(	24.86)(	49.73)(	74.59)(	124.32)(	198.91)(	248.64)(
ROUTED TO	BLO	7.49	1	273.	1024.	1972.	3981.	6748.	8354.
		(19.40)	(	7.73)(	29.01)(	55.85)(	112.74)(	191.09)(	236.56)(
ROUTED TO	CHR	7.49	1	248.	760.	1784.	3869.	6712.	8325.
		(19.40)	(	7.02)(	21.51)(	50.52)(	109.57)(	190.07)(	235.75)(
ROUTED TO	AHO	7.49	1	83.	384.	1044.	2868.	5346.	7152.
		(19.40)	(	2.35)(	10.87)(	29.57)(	81.20)(	151.38)(	202.53)(

SUMMARY OF DAM SAFETY ANALYSIS
BRADYS LAKE DAM

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM	
ELEVATION	1716.00	1716.00	1717.70	Low point, 1717 ft. in
STORAGE	1213.	1213.	1782.	natural
OUTFLOW	0.	0.	337.	ground.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	1717.52	0.00	1722.	273.	0.00	50.00	0.00
.20	1718.47	.77	2039.	1024.	5.67	49.33	0.00
.30	1718.92	1.22	2191.	1972.	7.33	47.33	0.00
.50	1719.47	1.77	2374.	3981.	8.67	45.67	0.00
.80	1720.01	2.31	2556.	6748.	10.00	45.00	0.00
1.00	1720.25	2.55	2692.	8354.	10.67	45.00	0.00

MFB 6/20/79 Bradys Lake Hydrology / Hydraulics SW 11 of 14

MGB 6/20/79 Bradys Lake Hydrology / Hydraulics Sh. 12 of 14

SUMMARY OF DAM SAFETY ANALYSIS
DOWNSTREAM CULVERT

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1662.00	1662.00	1672.30
STORAGE	0.	0.	161.
OUTFLOW	0.	0.	815.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	1665.34	0.00	22.	248.	0.00	50.00	0.00
.20	1671.57	0.00	126.	760.	0.00	50.00	0.00
.30	1675.26	2.96	302.	1784.	4.00	49.33	0.00
.50	1677.44	5.14	405.	3869.	6.33	46.33	0.00
.80	1679.28	6.98	493.	6712.	8.00	45.33	0.00
1.00	1680.13	7.83	533.	8325.	8.33	45.33	0.00

SUMMARY OF DAM SAFETY ANALYSIS
ARROWHEAD LAKE DAM

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM	
ELEVATION	1648.00	1648.00	1653.30	Low point of swale,
STORAGE	0.	0.	1203.	design elevation,
OUTFLOW	0.	0.	4832.	1655 ft.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	1648.35	0.00	80.	83.	0.00	50.00	0.00
.20	1648.98	0.00	222.	384.	0.00	50.00	0.00
.30	1649.91	0.00	433.	1044.	0.00	50.00	0.00
.50	1651.74	0.00	850.	2868.	0.00	50.00	0.00
.80	1653.65	.35	1283.	5346.	3.33	48.33	0.00
1.00	1654.73	1.43	1528.	7152.	5.00	47.67	0.00

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .10	RATIO 2 .20	RATIO 3 .30	RATIO 4 .50	RATIO 5 .80	RATIO 6 1.00
HYDROGRAPH AT	BLI	7.49	1	878.	1756.	2634.	4390.	7024.	8780.
		(19.40)	(	24.86)(	49.73)(	74.59)(	124.32)(	198.91)(	248.64)(
ROUTED TO	BLO	7.49	1	273.	1024.	1972.	4262.	7191.	9166.
Failure Assumed		(19.40)	(	7.73)(	29.01)(	55.85)(	120.70)(	203.62)(	259.54)(
ROUTED TO	CHR	7.49	1	248.	760.	1784.	4241.	7171.	9107.
		(19.40)	(	7.02)(	21.51)(	50.52)(	120.08)(	203.06)(	257.89)(
ROUTED TO	AHO	7.49	1	83.	384.	1044.	3326.	5724.	7500.
		(19.40)	(	2.35)(	10.87)(	29.57)(	94.20)(	162.09)(	212.39)(

SUMMARY OF DAM SAFETY ANALYSIS
BRADYS LAKE DAM - Failure Assumed

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
0.	1.00	1704.00	4.00	1716.00	1719.20

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM	
ELEVATION	1716.00	1716.00	1717.70	Low point, 1717 ft.
STORAGE	1213.	1213.	1782.	in natural ground.
OUTFLOW	0.	0.	337.	

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	1717.52	0.00	1722.	273.	0.00	50.00	0.00
.20	1718.47	.77	2039.	1024.	5.67	49.33	0.00
.30	1718.92	1.22	2191.	1972.	7.33	47.33	0.00
.50	1719.44	1.74	2367.	4262.	8.67	48.00	44.00
.80	1719.93	2.23	2529.	7191.	10.00	45.67	42.33
1.00	1720.15	2.45	2637.	9166.	10.67	45.67	41.67

MFB 6/20/79 Bradys Lake Hydrology/Hydraulics SH. 14 OF 14

SUMMARY OF DAM SAFETY ANALYSIS

DOWNSTREAM CULVERT - No Failure Assumed

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1662.00	1662.00	1672.30
STORAGE	0.	0.	161.
OUTFLOW	0.	0.	815.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	1665.34	0.00	22.	248.	0.00	50.00	0.00
.20	1671.57	0.00	126.	760.	0.00	50.00	0.00
.30	1675.26	2.96	302.	1784.	4.00	49.33	0.00
.50	1677.72	5.42	419.	4241.	6.33	48.00	0.00
.80	1679.53	7.23	504.	7171.	8.00	46.00	0.00
1.00	1680.52	8.22	552.	9107.	8.33	45.67	0.00

SUMMARY OF DAM SAFETY ANALYSIS

ARROWHEAD LAKE DAM - No Failure Assumed

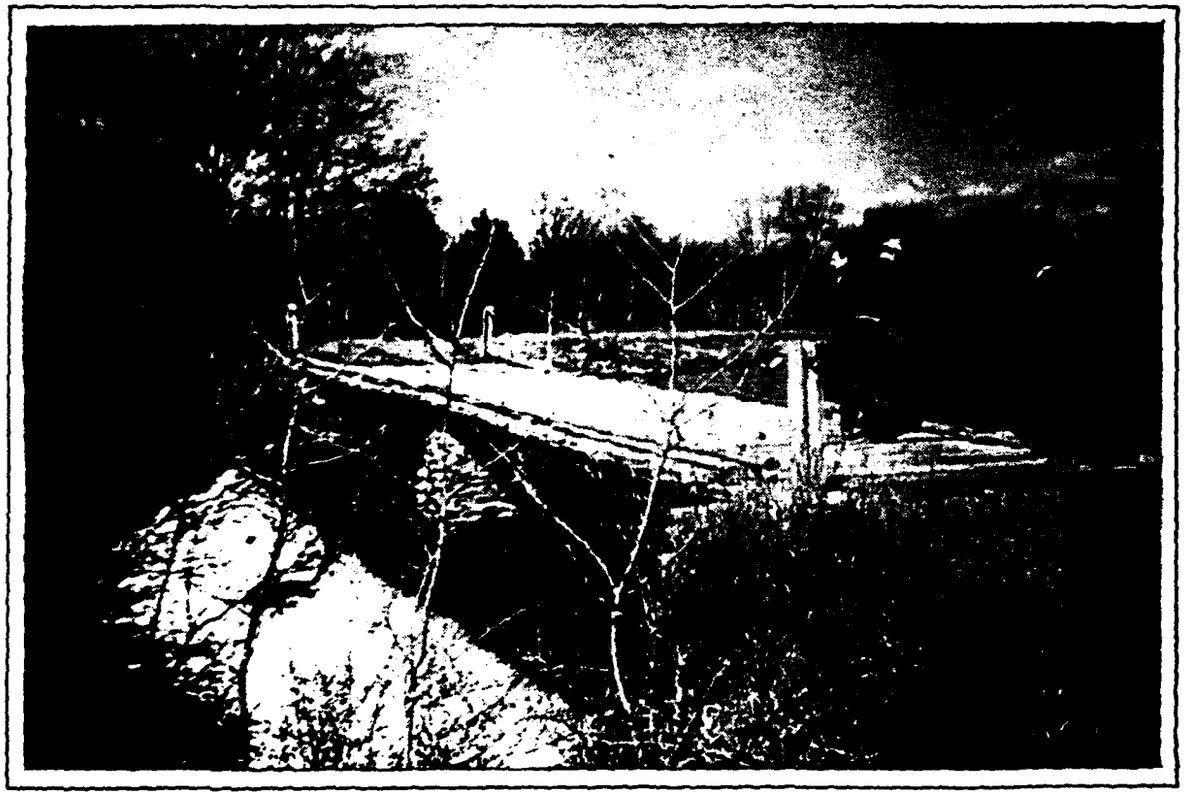
	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1648.00	1648.00	1653.30
STORAGE	0.	0.	1203.
OUTFLOW	0.	0.	4832.

Low point of swale, design elevation, 1655 ft.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	1648.35	0.00	80.	83.	0.00	50.00	0.00
.20	1648.98	0.00	222.	384.	0.00	50.00	0.00
.30	1649.91	0.00	433.	1044.	0.00	50.00	0.00
.50	1652.13	0.00	938.	3326.	0.00	50.00	0.00
.80	1653.90	.60	1339.	5724.	3.67	48.00	0.00
1.00	1654.92	1.62	1570.	7500.	5.00	47.33	0.00

APPENDIX

D



OVERVIEW OF SPILLWAY.

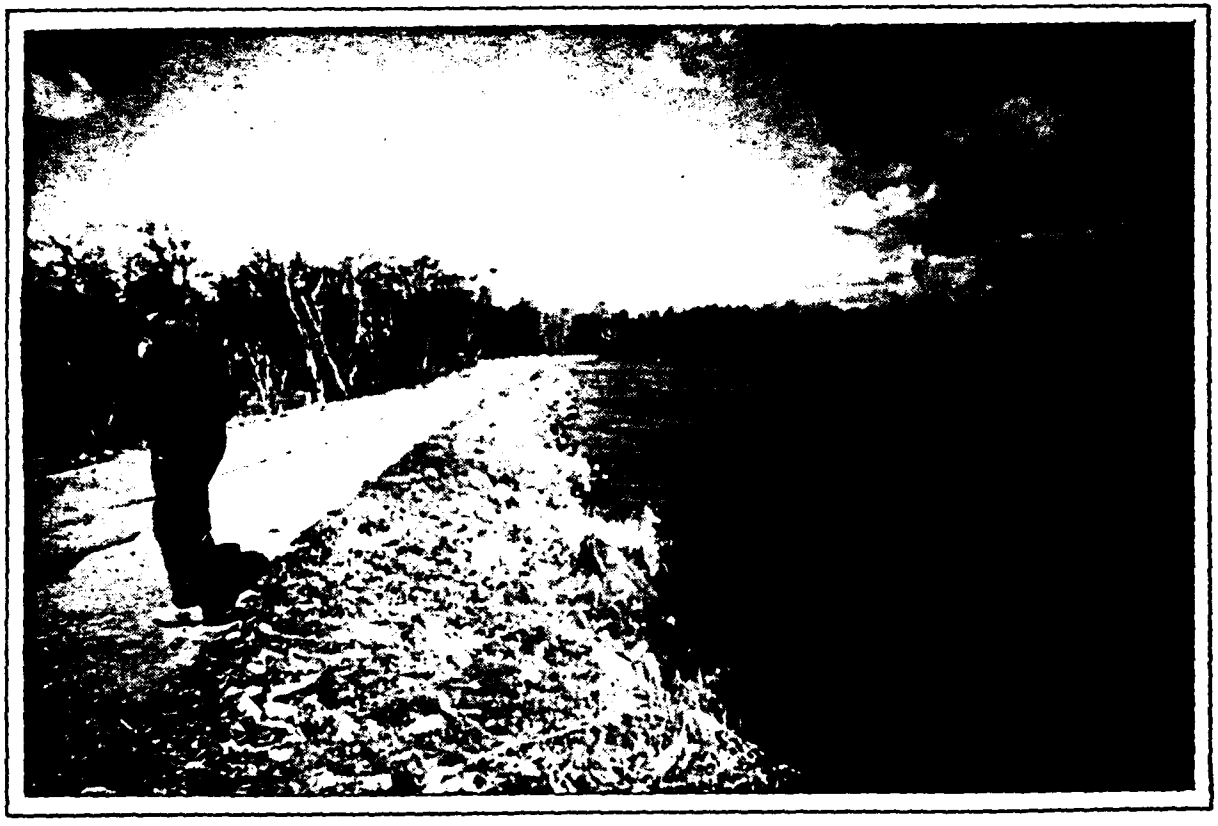
PHOTOGRAPH NO. 1

ALTERNATE OVERVIEW OF SPILLWAY.

PHOTOGRAPH NO. 2

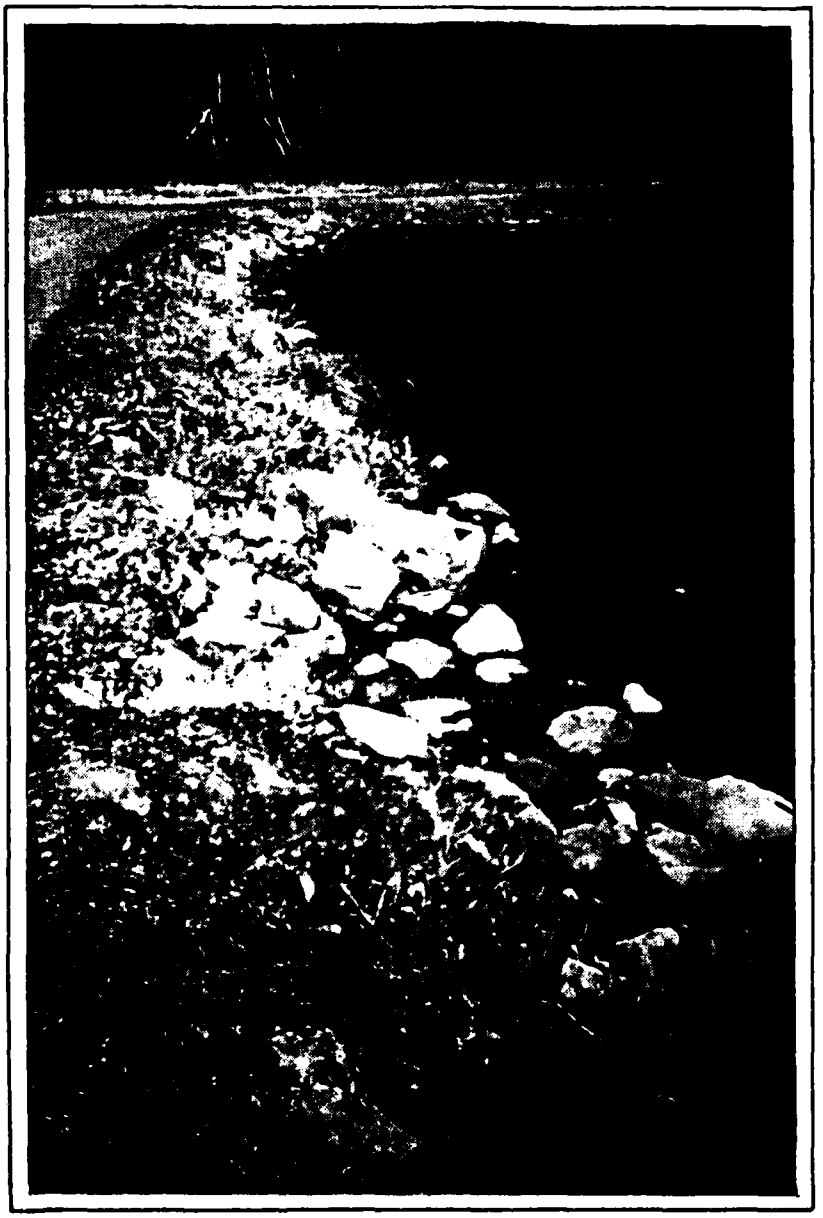
SPILLWAY LOOKING UPSTREAM. NOTE
CLEARANCE BETWEEN CREST AND BRIDGE.

PHOTOGRAPH NO. 3



OVERVIEW OF UPSTREAM SLOPE

PHOTOGRAPH NO. 4



OVERVIEW OF UPSTREAM SLOPE
AT RIGHT END OF EMBANKMENT.

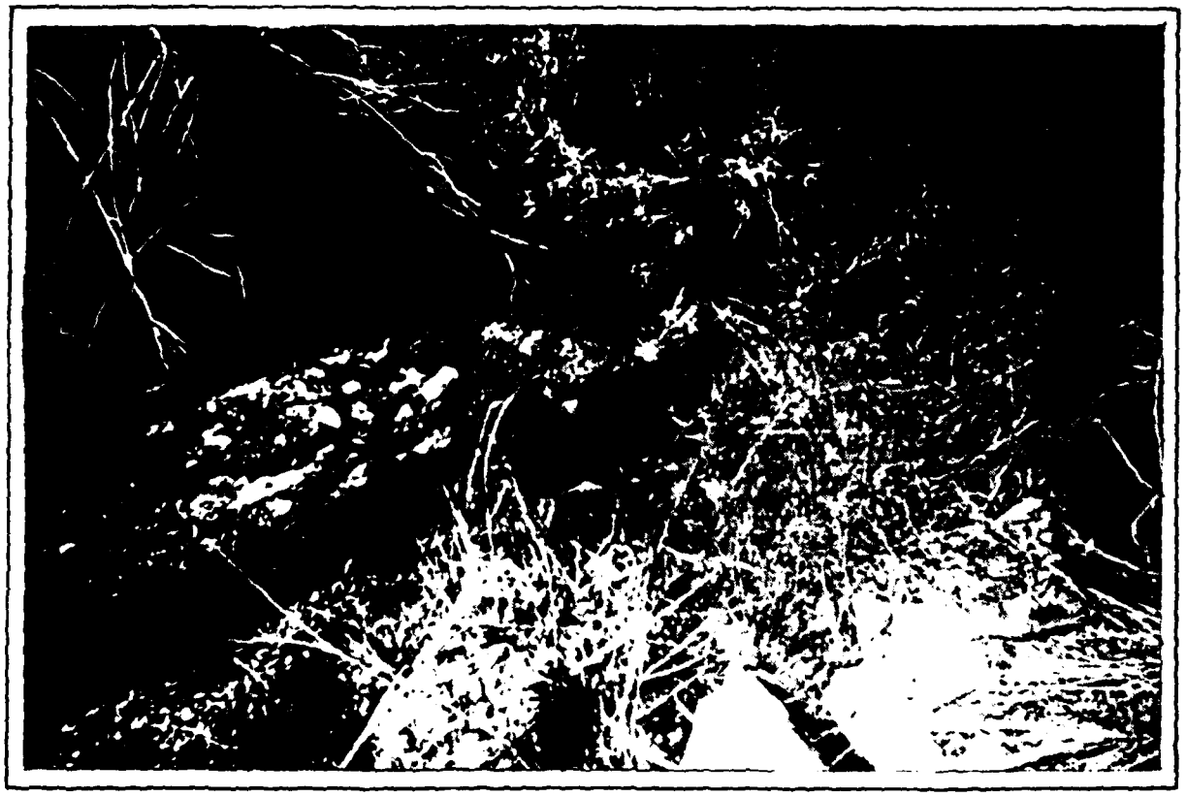
PHOTOGRAPH NO. 5

OVERVIEW OF DOWNSTREAM SLOPE.

PHOTOGRAPH NO. 7

OVERVIEW OF SWAMP BELOW THE DAM.

PHOTOGRAPH NO. 8

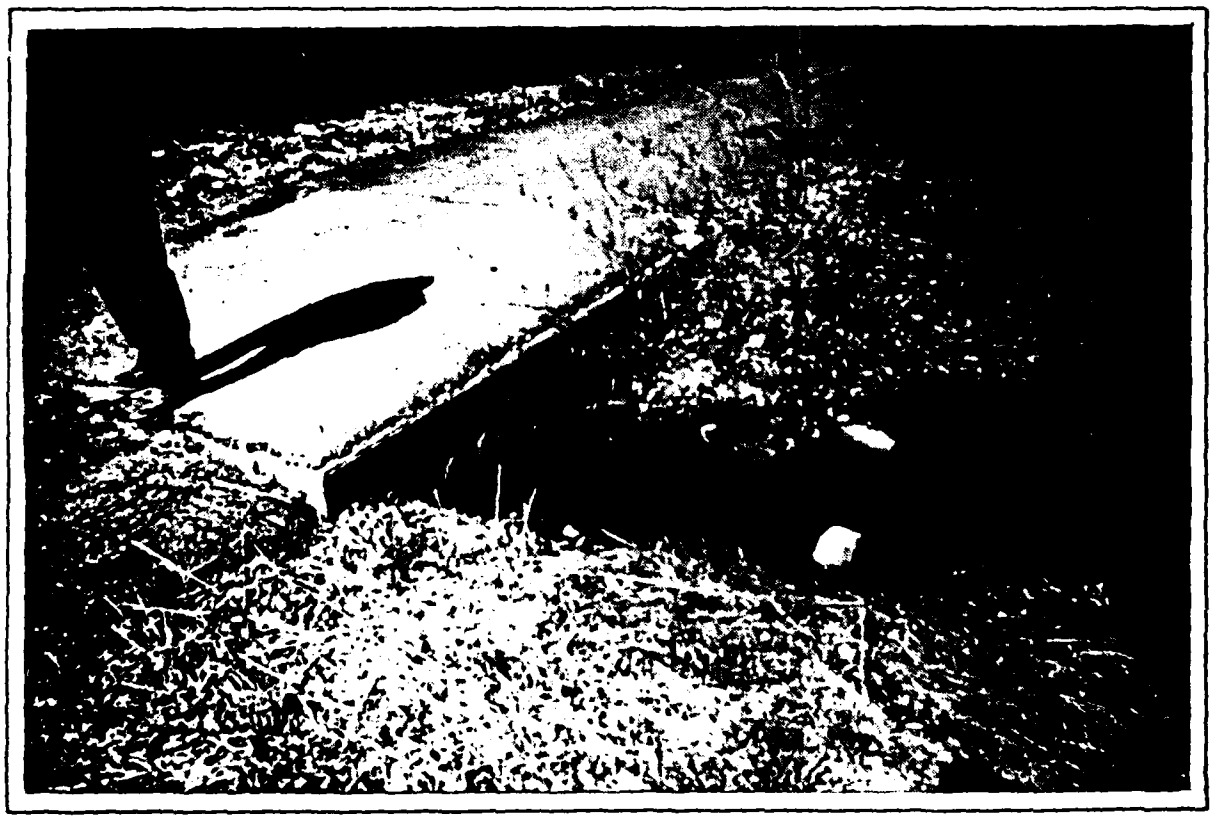


SEEPAGE THROUGH DOWNSTREAM TOE.

PHOTOGRAPH NO. 9

OVERVIEW OF OVERFLOW AREA AT LEFT
END OF EMBANKMENT.

PHOTOGRAPH NO. 10

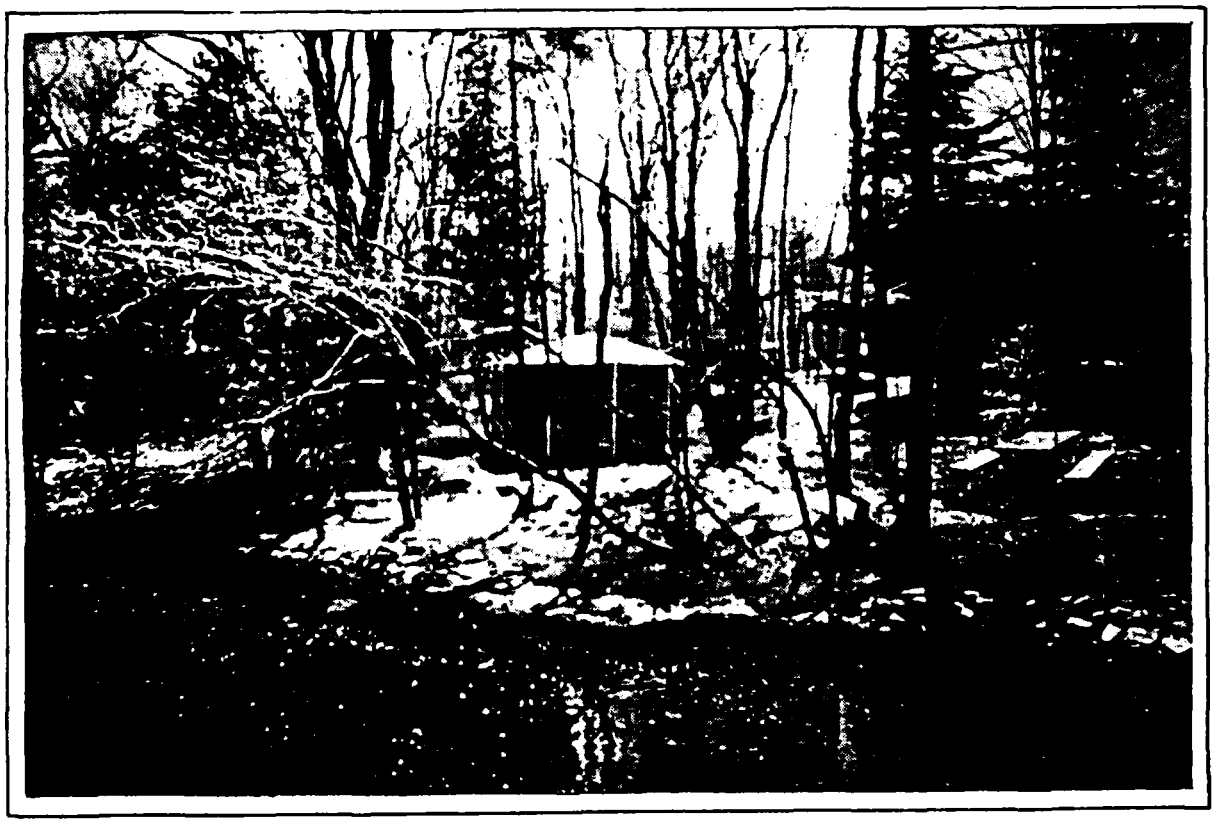


DISCHARGE PIPE AT LEFT END OF
EMBANKMENT.

PHOTOGRAPH NO. 11

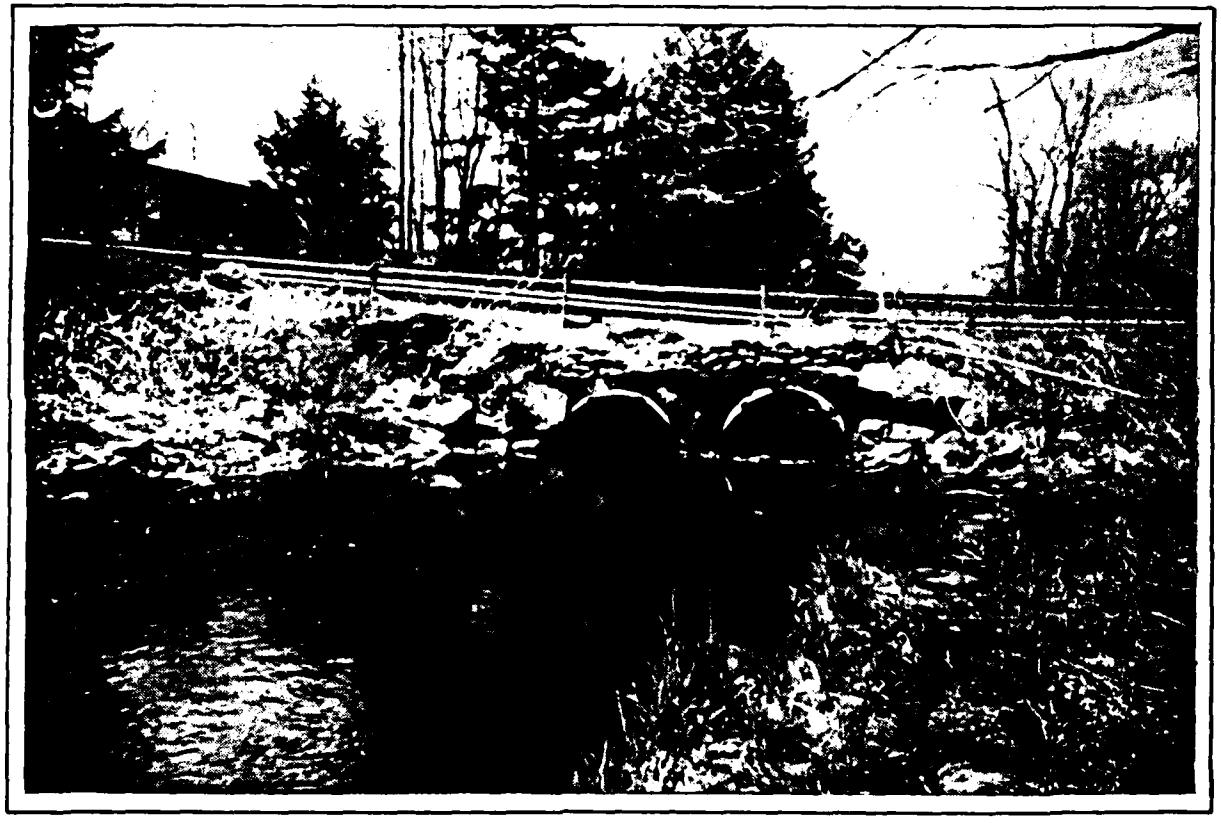
ASPHALT PAVEMENT CRACKING
ALONG CREST OF DAM.

PHOTOGRAPH NO. 12



HOMES ALONG CREEK DOWNSTREAM OF DAM.

PHOTOGRAPH NO. 13



FIRST BRIDGE BELOW DAM.

PHOTOGRAPH NO. 14

OUTLET PIPES OF FIRST BRIDGE BELOW DAM.

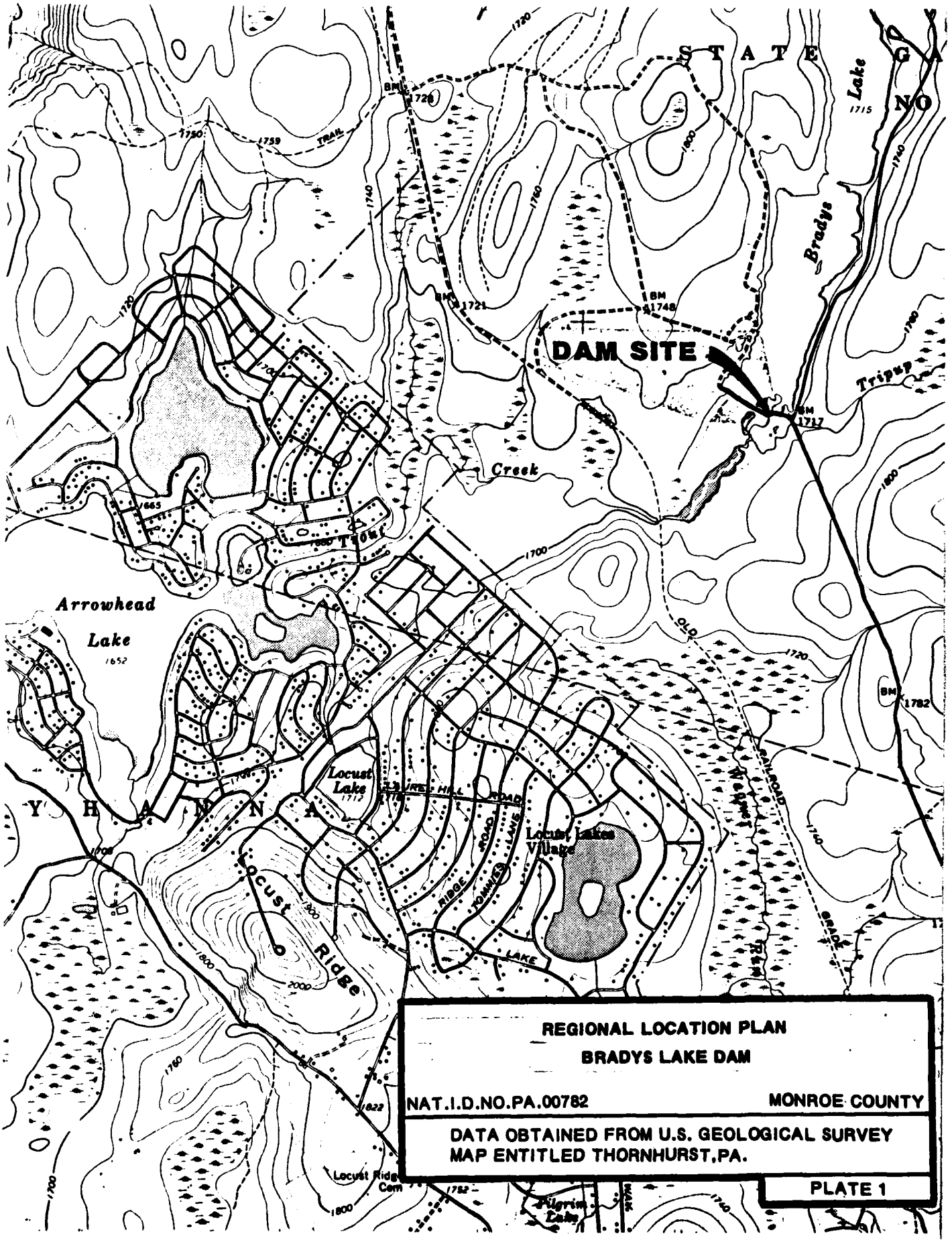
PHOTOGRAPH NO. 15

OVERVIEW OF ARROWHEAD LAKE AND DAM
DOWNSTREAM.

PHOTOGRAPH NO. 16

APPENDIX

E



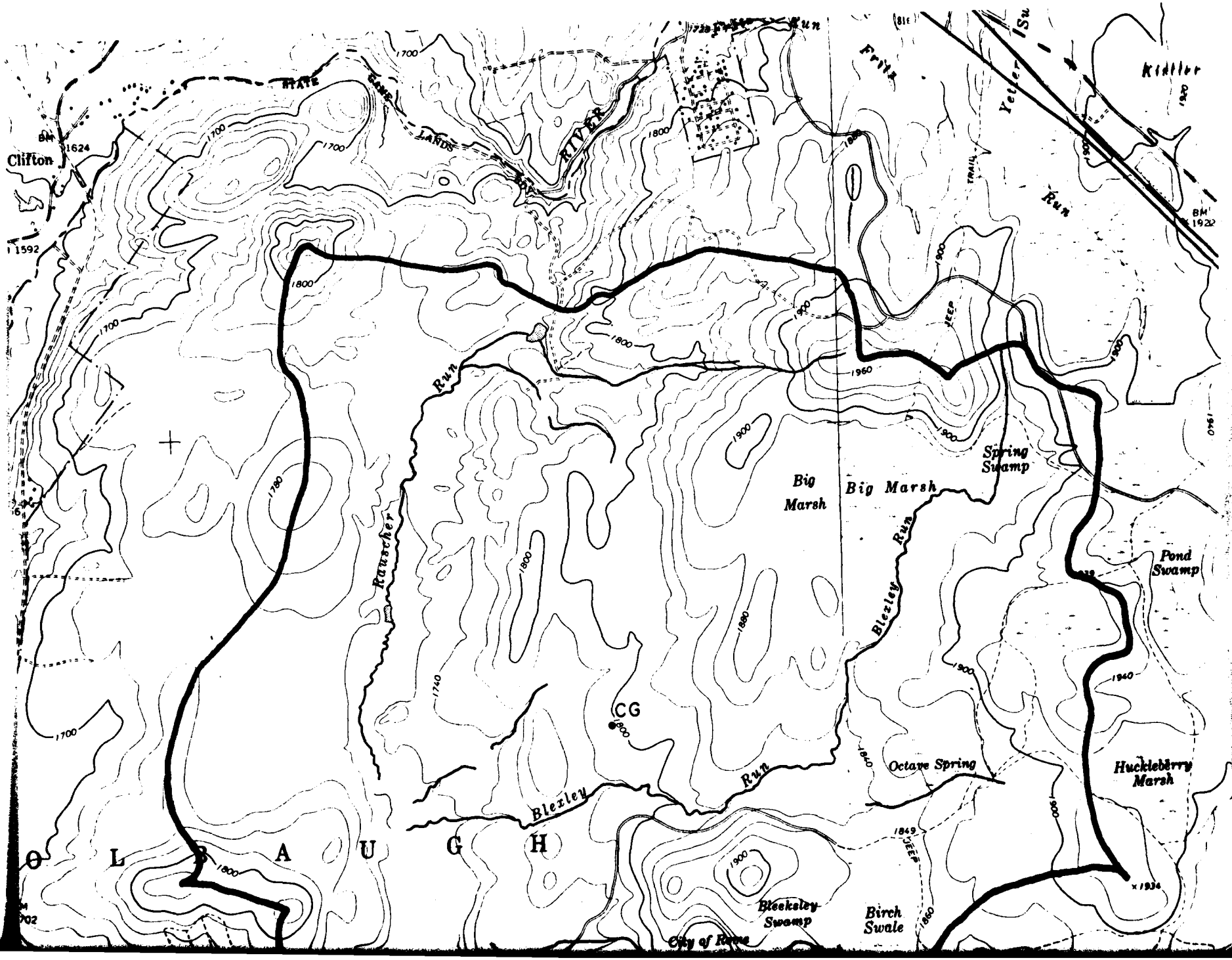
REGIONAL LOCATION PLAN

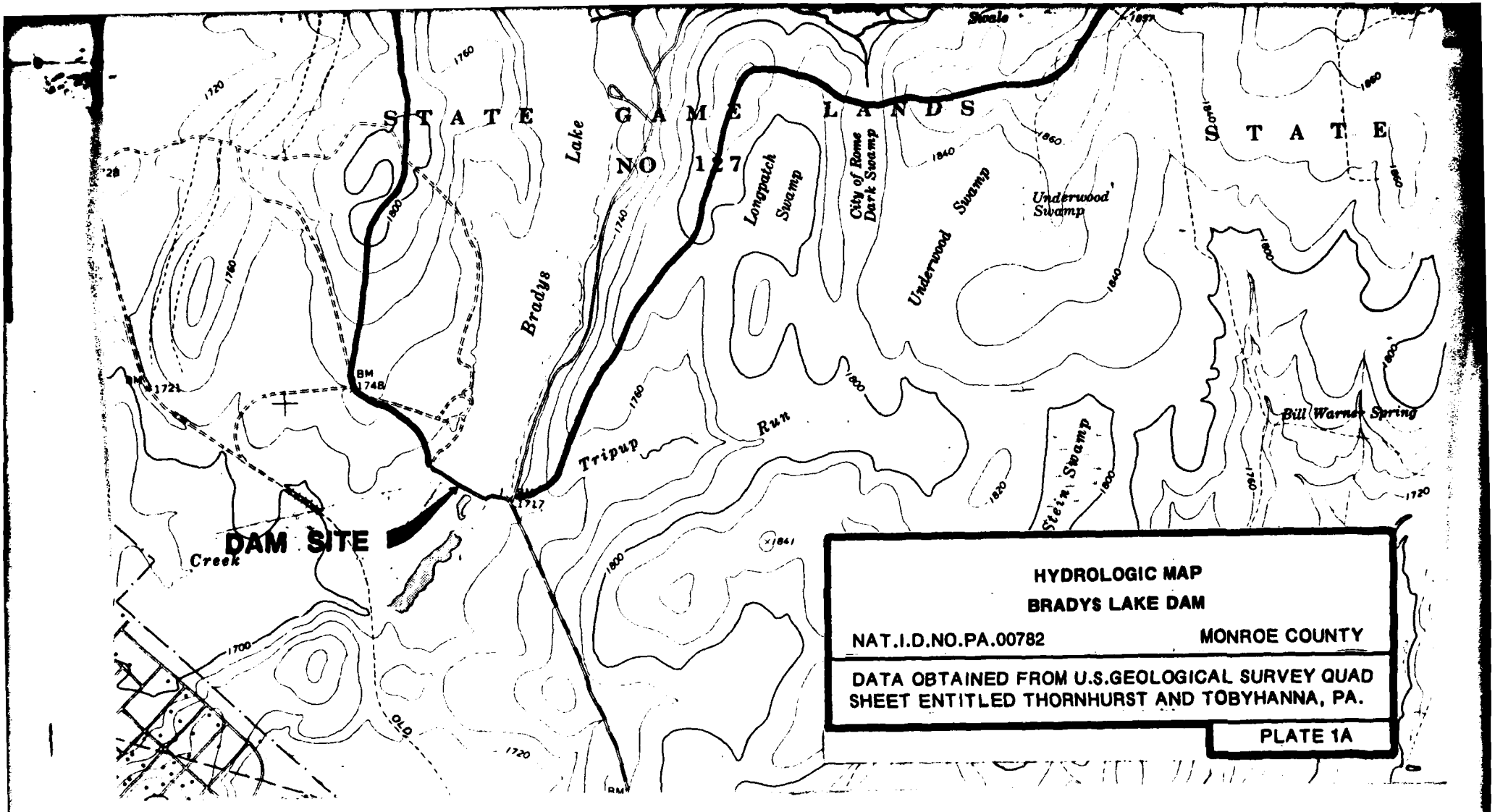
BRADYS LAKE DAM

NAT.I.D.NO.PA.00782 MONROE COUNTY

DATA OBTAINED FROM U.S. GEOLOGICAL SURVEY MAP ENTITLED THORNHURST,PA.

PLATE 1


Clifton
BM 1624
1592
STATE
GAME LANDS
RIVER
Run
Kistler
BM 1922
TRAIL
JEEP
Rauscher Run
Big Marsh
Big Marsh
Spring Swamp
Blexley Run
Pond Swamp
CG
Octave Spring
Huckleberry Marsh
Blexley Run
Bleeksley Swamp
Birch Swale
City of Rocks
1700
1800
1900
1940
1960
1780
1740
1849
1860
1934
O L A U G H



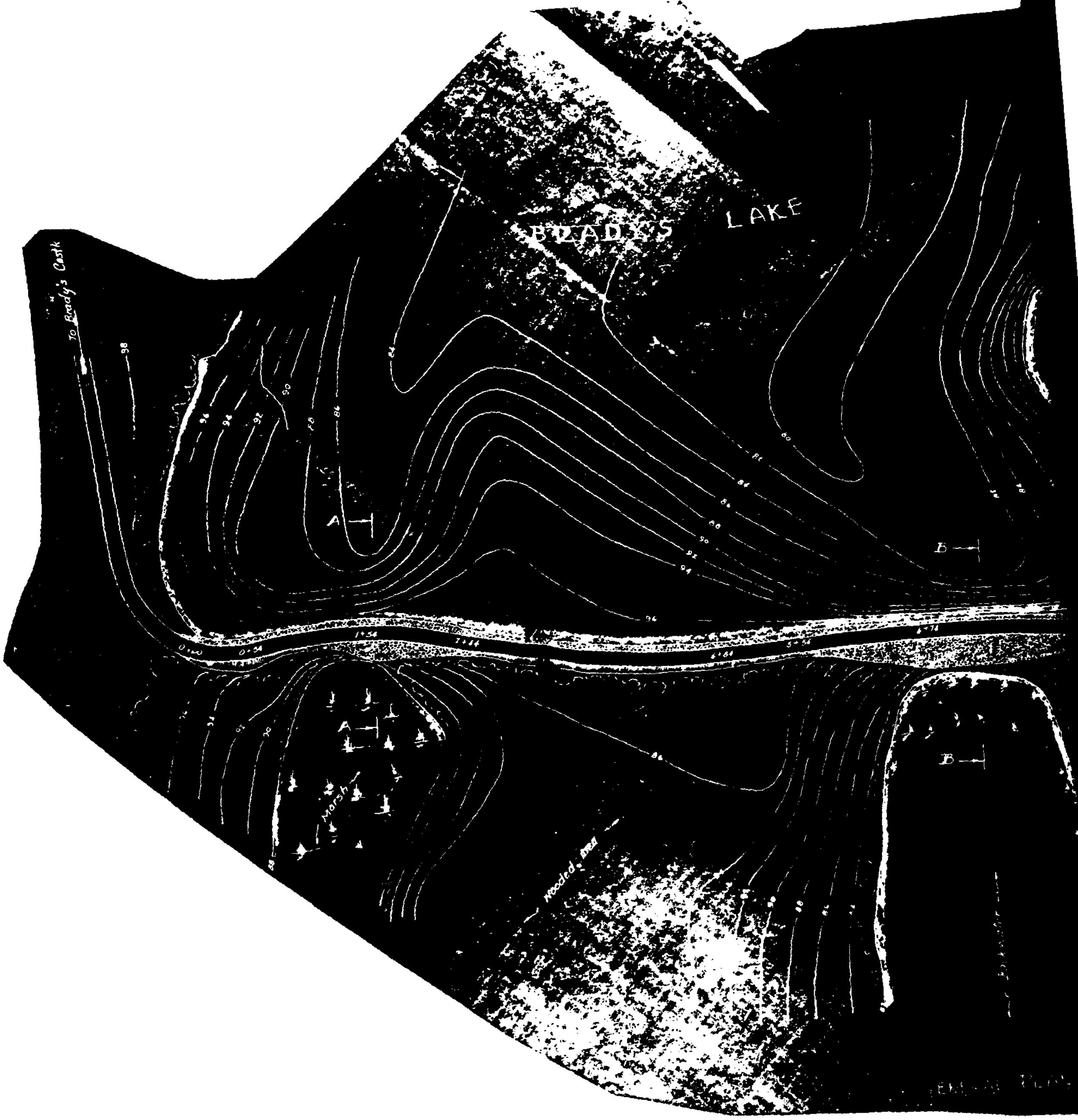
HYDROLOGIC MAP

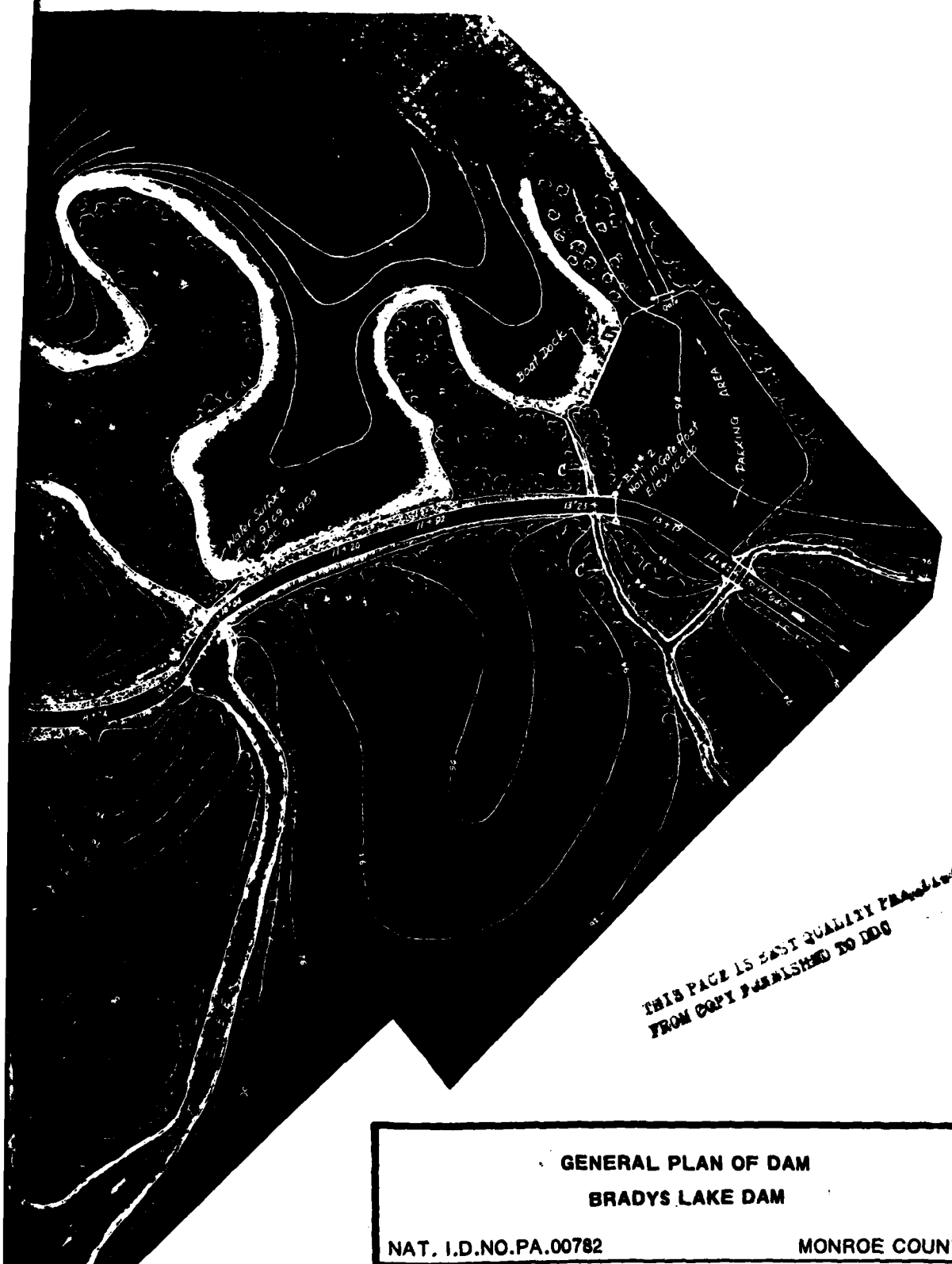
BRADYS LAKE DAM

NAT.I.D.NO.PA.00782 MONROE COUNTY

DATA OBTAINED FROM U.S.GEOLOGICAL SURVEY QUAD SHEET ENTITLED THORNHURST AND TOBYHANNA, PA.

PLATE 1A


BRADY'S LAKE
A
B
Marsh



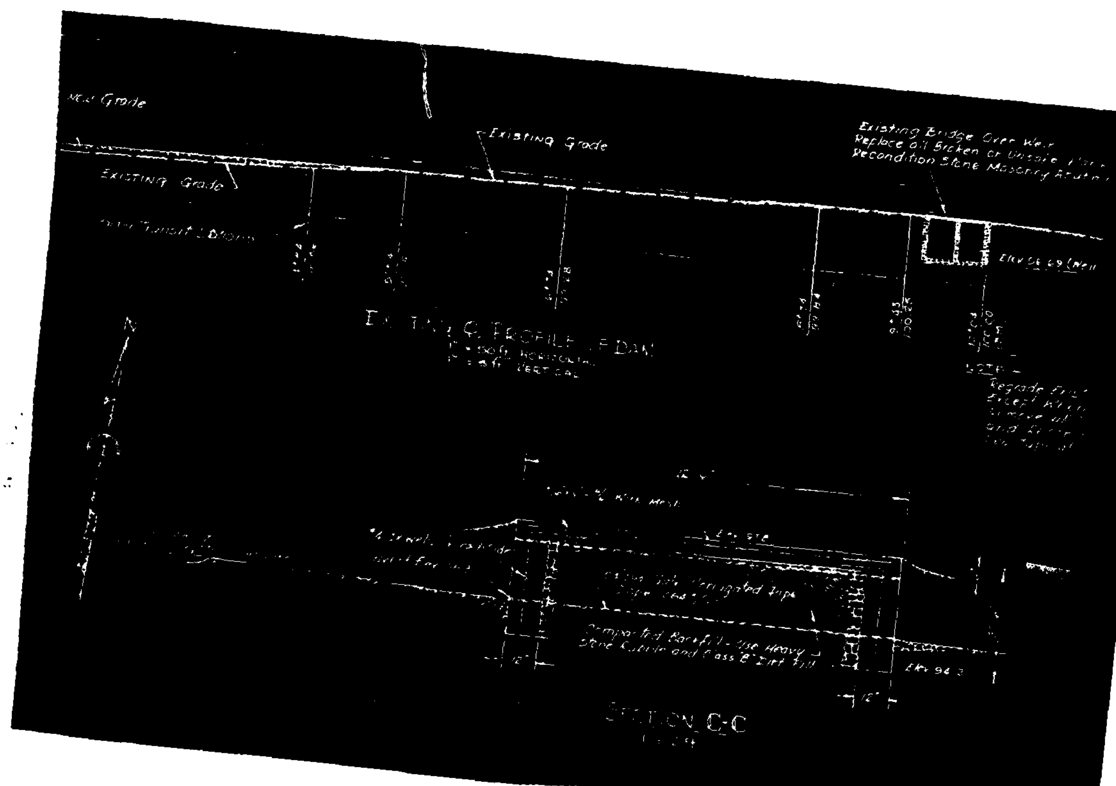
GENERAL PLAN OF DAM

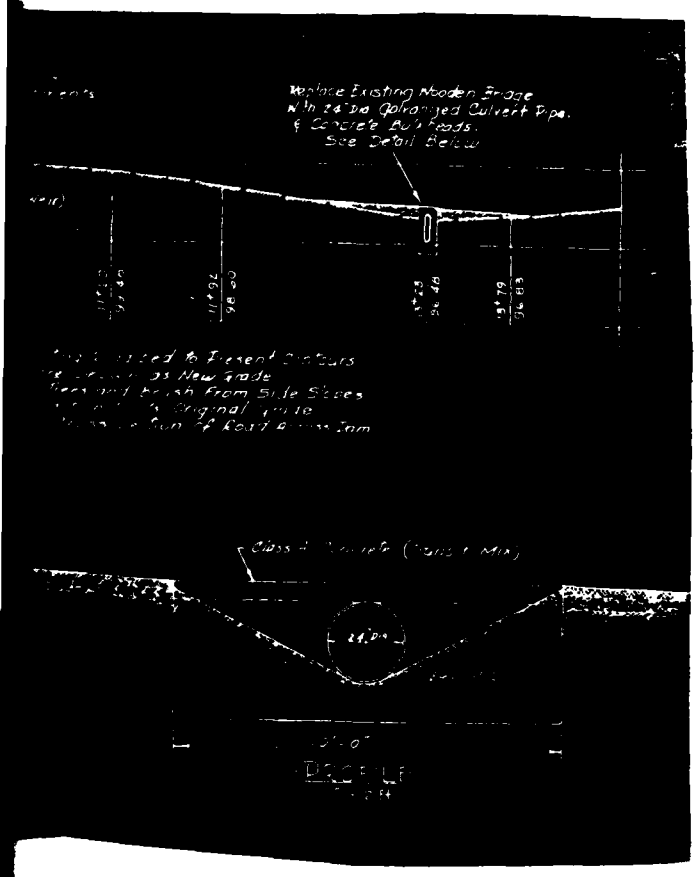
BRADYS LAKE DAM

NAT. I.D.NO.PA.00782 MONROE COUNTY

DATA OBTAINED FROM COMMONWEALTH OF PENNSYLVANIA DEPT. OF PROPERTY AND SUPPLIES, PROJECT NO. 3697-OM SHEET NO. 2, DATED 6/16/60

PLATE 2


Existing Grade
Existing Grade
Existing Bridge Over Weir
Replace all Broken or Unsafe
Recondition Stone Masonry
Compacted Backfill - Use Heavy
Stone Rubble and Class "B" Dirt Fill
SECTION C-C



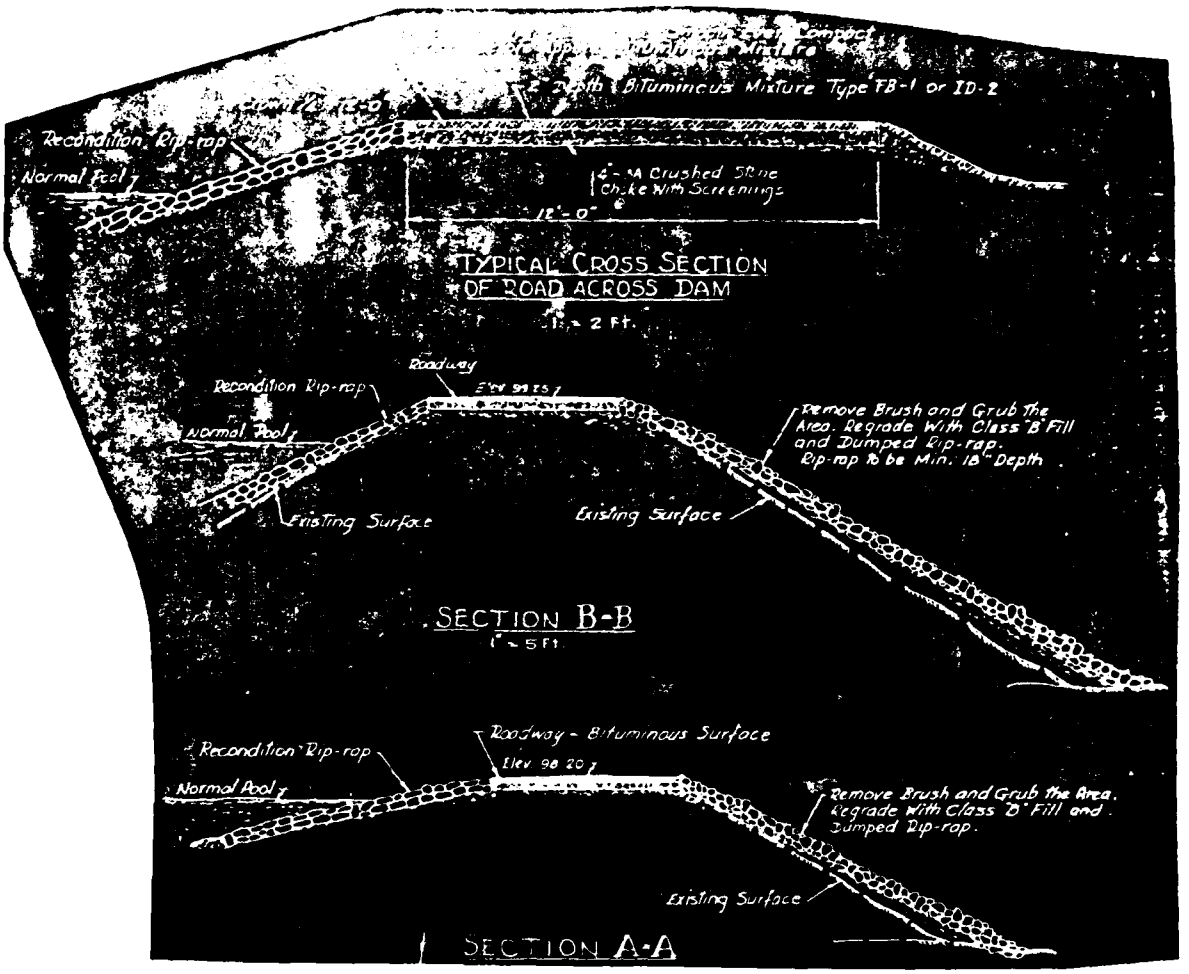
PLAN OF SPILLWAY AND CENTERLINE PROFILE

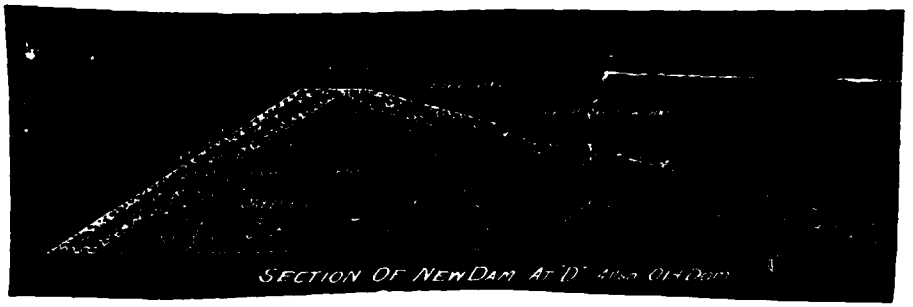
BRADYS LAKE DAM

NAT. I.D.NO.PA.00782 **MONROE COUNTY**

DATA OBTAINED FROM COMMONWEALTH OF PENNSYLVANIA DEPT. OF PROPERTY AND SUPPLIES, PROJECT NO. 3697-OM SHEET NO. 2, DATED 6/16/60

PLATE 3





TYPICAL EMBANKMENT SECTIONS
BRADYS LAKE DAM

NAT.I.D.NO.PA.00782 MONROE COUNTY

DATA OBTAINED FROM COMMONWEALTH OF PENNSYLVANIA DEPT. OF PROPERTY AND SUPPLIES, PROJECT NO. 3697-OM SHEET NO. 2, DATED 6/16/60

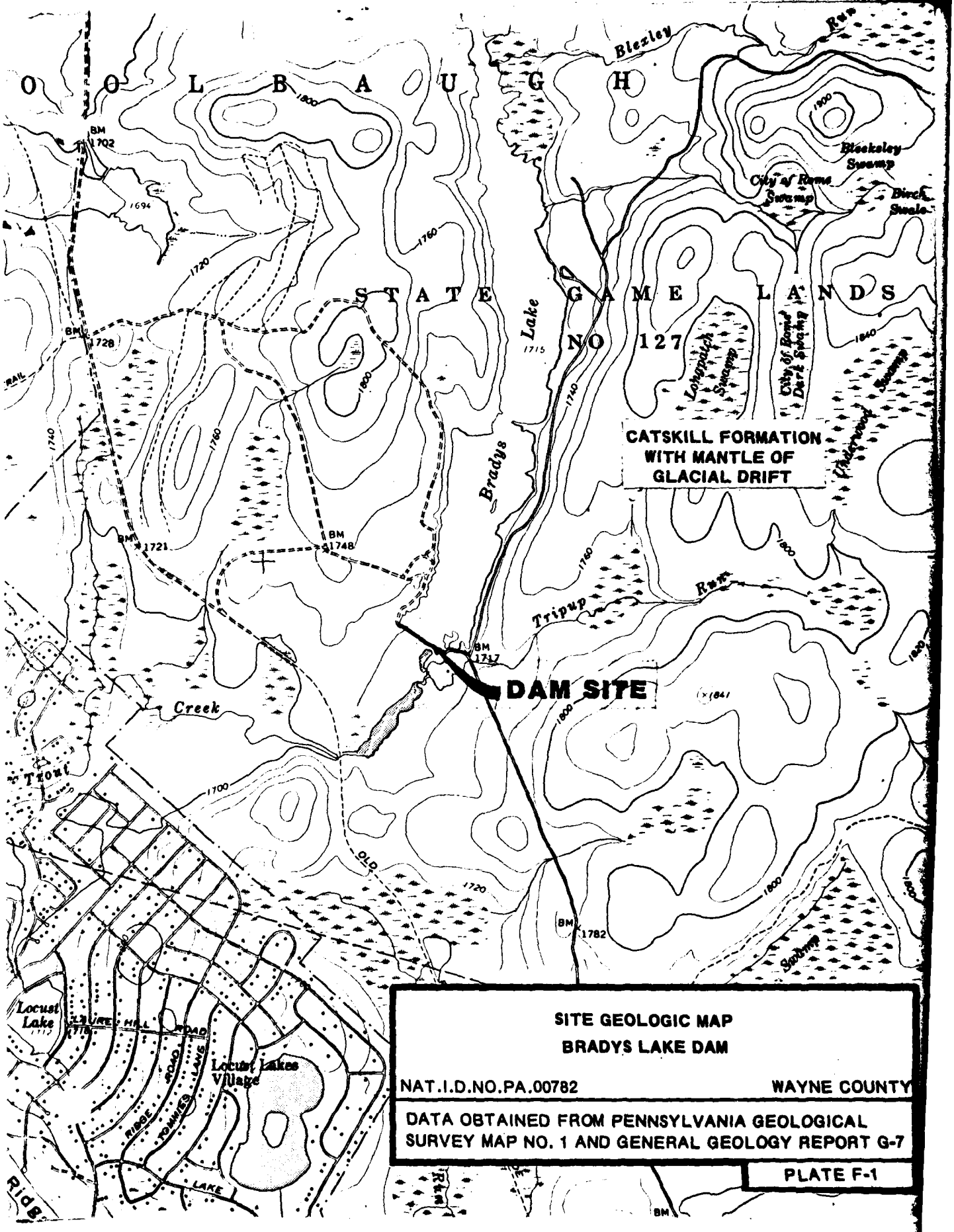
PLATE 4

APPENDIX

F

SITE GEOLOGY
BRADYS DAM

Bradys Dam is located in the Pocono Plateau Section of the Appalachian Plateaus Physiographic Province. As shown on Plate F-1, the dam and surrounding region, as is much of northeastern Pennsylvania, are underlain by the Upper Devonian age Catskill Formation, which is overlain by a partial mantle of Wisconsin age glacial drift. No bedrock exposures were observed during the field inspection. However, the Catskill Formation in this region characteristically consists of sandstone and conglomerate having interbeds of siltstone. The glacial drift in the immediate dam site areas was noticeably boulder-rich. From available data in State files, it is most likely that the dam is founded entirely upon glacial drift, which may account for the seepage observed.



SITE GEOLOGIC MAP
BRADYS LAKE DAM

NAT.I.D.NO.PA.00782 WAYNE COUNTY

DATA OBTAINED FROM PENNSYLVANIA GEOLOGICAL SURVEY MAP NO. 1 AND GENERAL GEOLOGY REPORT G-7

PLATE F-1